TEXT-BOOK OF ORTHOPÆDIC MEDICINE

VOLUME I

DIAGNOSIS OF SOFT TISSUE LESIONS

By

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PREFACE

ONE of the commonest of patients' complaints is of pain affecting a moving part of the body Not all such symptoms, of course, result from a local dis order, but a great many do, moreover lesions affecting the limbs and the moving parts of the trunk are extremely frequent. Thus muscles and tendons become strained, liga ments suffer adhesion formation after partial rupture joints become arthritic or develop internal derangement, nerves may be subjected to pressure from outside.

What specialty is to cater for this large mass of patients who wander from doctor to doctor or department to depart ment, in the hope of receiving expert attention? These disorders are not rheumatic (though often called so by the patient) for they have no connexion with rheumatic fever or rheumatoid arthritis They seldom call for treatment by surgery Hence the conditions under discussion are not primarily the concern of the rheumatologist or the orthopædic surgeon. Usually, however, they require treatment by physical methods. Such treatment consists of manipula tion, deep massage, local anæsthesia, traction immobilization, electrotherapy and exercises—all methods in which (except for the last two) practitioners of physical medicine have so far shown little interest. Moreover the advent of important advances in electro-diagnosis (*e.g.* electromyography, electro-encephalography) has taken the consultant in physical medicine into special diagnostic fields of his own, in col laboration with the neurologist. This leads away from everyday clinical matters and provides added justification for the new specialty with which this book is concerned—orthopædic medicine.

The time is clearly approaching when the technique of electromyography will become standardized enough for the neurologist merely to employ a trained technician for most purposes. Again, the transfer of the rheumatoid disorders from the sphere of rheumatology to that of endocrinology will not be long delayed These two events will inevitably remove the two chief pillars maintaining the edifice of physical

THE FUTURE OF ORTHOPÆDIC MEDICINE

NOTE TO THE THIRD EDITION

IT becomes increasingly clear that the future of orthopædic medicine lies with the family doctor. Eventually, in a mechanized age, this work may provide his last refuge. There are indeed few disorders of the viscera, blood, nervous system or bone that do not call for reference to a hospital for radiography, laboratory tests and so forth. By contrast, in orthopædic medicine, the entire resources of a large hospital bring little or nothing positive to bear on the patient's disorder. Hence many hospitals, otherwise amply equipped but lacking an orthopædic physician, have no means of dealing adequately with, for example, a simple early disc lesion, a sprained knee, a painful shoulder or a tennis elbow. Yet estimates place such disorders as providing a fifth of all attendances of a family doctor.

In justice to his patients, and to prevent their lingering off work needlessly, the family doctor must do what the hospital does not do. More and more doctors are realizing this fact, spurred by their patients' tales of cures by laymen. It is particularly fortunate therefore that diagnosis is a purely clinical matter and that treatment (apart from some syringes) requires only a pair of instructed hands.

September 1956

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MANY indeed have helped and supported me
My thanks are due to the editors of the *British Medical Journal*, the *Lancet*, the *Journal of Bone and Joint Surgery* and the *Postgraduate Medical Journal* for kindly allowing the incorporation of material that has already appeared in their pages, to Drs. Coldwell, Flood and McLaren who took the radiographs, to Drs. Haldemann and Soto-Hall for permission to reproduce Plate 81, to Messrs Burns and Young for permission to reproduce Fig 66, and to Professor Laurence for Fig 67 to Mrs M. Rothenstein and Miss J Farmer who drew the illustrations, outlining difficult subjects with remarkable fidelity and insight to Mr O Drury, the photographer for his perseverance and skill to Messrs Cassell for their help in the preparation of the manuscript for publication

To these acknowledgements I am happy to add an expression of my gratitude to my first physiotherapist, now Mrs. Keating who for eleven years helped me on my way with never failing loyalty to Miss Dandridge, Miss Hickling (who spent a year in New Zealand demonstrating our work) Miss Moffatt and Mrs Skillern, who have followed so ably in her footsteps, to Mr F Kaltenborn who brought our methods to Norway and to my wife who, as member of the Council of the Chartered Society of Physiotherapy, sustained both the buffets and the ultimate satisfaction of shepherding new work towards investigation and ultimate acceptance. Dr O Troisier requires special mention for his zeal and ability leading to the adoption of these methods in France and to the making of our film on diagnosis at the shoulder Mrs Hearn, who introduced our methods in Brazil, deserves particular praise for her scrupulous revision of the manuscript.

Finally it is with pleasure that my wife and I record our great debt to medical men and practising physiotherapists all over the country Their interest and support have spurred us on at times of doubt and difficulty, to complete the work that makes possible full and harmonious collaboration between our two professions.

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CHAPTER I

MEDICAL FALLACIES

WHEN a part of medicine is in its infancy, doctors (like other experts in other walks of life) coin words and phrases These convey meaning but often do not elucidate the nature of the matter in hand For example, "consumption" once indicated, as between one medical man and another, a syndrome that both recognized but the label had no ætiological significance. Until recently, orthopædic medicine has been elaborately clouded by names—rheumatism, fibrositis and so on—that possess no meaning Non articular rheumatism is a particularly high sounding nebula. In order therefore to approach this book with an open mind, the reader is asked consciously to divest himself of a number of preconceptions and, even more, to discard labels devoid both of anatomical and of pathological significance. In this preliminary chapter, an attempt is made to clear the air

All pains have a source the diagnosis names it. In the case of visceral disease, interference with function may be difficult or impossible to demonstrate, even with the most delicate and elaborate apparatus In the case of moving parts, on the other hand, function is obvious and very easy to test clinically A joint moves within certain known limits, a voluntary muscle contracts and relaxes again to known effect. The examination of these two functions presents no difficulty whatever and the interpretation of findings is merely a matter of applied anatomy The basis of this book is thus extreme simplicity, it is novel merely because a factual and clinical approach on these lines to locomotor disorders has not been attempted before.

Unfortunately, by basing my beliefs on the result of adequate clinical examination I have been led to concepts much at variance with those previously accepted This has hurt myself as much as others Being slowly forced to abandon what one has been taught under pressure of repeated clinical findings is a painful business meeting much internal

resistance. Schooling oneself by logic to accept an unwelcome alternative is also a painful business, from which I have suffered more than most doctors owing to the immense strides that orthopædic medicine has taken during the last decade.

I would therefore beg my readers—not to mention my reviewers—to start from scratch, neither believing nor disbelieving prematurely, but examining patients on the lines laid down and then noting the syndromes that emerge. Physical signs do not deceive, and if they run counter to today's theories, so much the better for tomorrow's fact.

"RHEUMATISM"

Nomenclature in medicine is always important, for it is by words that we convey our meaning to others. Words can stimulate, but can also be used with deadly effect to put ourselves to sleep. Of soporific terms, none has lately proved a greater bar to progress than "rheumatism." Indeed, for years I have been asking myself "What is rheumatism?" and have been driven to the conclusion that it is a purely negative concept. It is rheumatism, seemingly, when it is nothing else; by corollary, as soon as the cause is known it is no longer rheumatism. Thus, a layman's definition might well be "pain apparently arising from a moving part of the body for no clear reason."

Rheumatic fever, chorea and their sequelæ, all well-defined clinical entities, are the only disorders to which, in my view, the word "rheumatic" usefully applies. In that connexion it has a positive meaning, which we all understand. But it is difficult to arrive at any acceptable concept of what "rheumatic" can mean when applied to disorders unconnected with rheumatic fever. Rheumatism has to do with the moving parts of the body, but by no means with all conditions affecting them. By common consent, osteoarthritis is rheumatic; osteo-arthritis with a loose body, impaction of which is causing the symptoms, and neuropathic and pulmonary arthropathy are probably not; tuberculous and gouty arthritis are certainly not. Infective arthritis is rheumatic; the locally identical condition occurring in serum sickness is not, because its allergic origin is obvious. Gono-

coccal arthritis is rheumatic only so long as its provenance remains undetected. Tabes, tumours invading bone, localized neuritis, or displaced fragments of intervertebral disc set up pains felt in muscles and joints these conditions are regarded as rheumatic or fibrositic only when the true nature of the condition is overlooked A familiar example is lumbago, until recently it was regarded as the result of fibrositis caused by rheumatic toxins settling in the lumbar muscles, now that it is known to be caused by internal derangement of a lumbar joint, it has ceased to be rheumatic. Tennis-elbow and supraspinatus tendinitis were thought of as rheumatism of the elbow and shoulder only so long as the traumatic cause of these two types of tendinitis was not realized When the ætiology of rheumatoid and spondylitic arthritis is ultimately found, this group of disorders will also cease to be caused by "rheumatism." The medical usage of the word can then finally cease (apart from rheumatic fever) Thereafter "rheumatic" would remain a useful evasion in casual speech but it would no longer be believed to carry any medical meaning

I know from my own experience the hypnotic effect of this word. Fifteen years ago I saw many patients in whom I could make no better guess at the cause of symptoms than that the tissues had been attacked by "rheumatism." Since then clinical experience has taught me that all pains have a finite source and that, as soon as this has been singled out, the condition is automatically lifted out of the limbo of "rheumatism" by the substitution of a properly descriptive label. Alternatively, it may be possible to show that the pains originate in the patient's mind, then, too the word "rheumatic" must be dropped, since psychogenic pain is clearly not rheumatism.

A firm factual basis for future research can be provided only if the idea is wholly erased that there exists a group of diseases caused by "rheumatism" attacking the moving parts of the body, and that it is for this noxious agent that a cure has to be sought Only in rheumatoid arthritis—which is known by that name and therefore need not be called "rheumatism"—is it at all probable that a systemic toxin is present.

The word "rheumatism" has another disadvantage. Since

it possesses no real medical meaning and is applied to all sorts of painful conditions, it means quite different things to different patients. Thus one patient may be deeply relieved to know that his pain is "only rheumatism"; another is appalled, since a relation of his is, say, crippled by "rheumatism" in every joint. Some patients develop an unsatisfactory attitude towards a chronic disability; a psychogenic element grows easily enough of itself, without doctors' aid, in patients disposed that way. The quickest manner of allaying anxiety and of nipping a budding overlay is to make a correct diagnosis and to explain to the patient in simple words what the matter is.

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"Rheumatic" inflammation of the soft tissues was postulated as existing and to be the cause of lumbago by Sir William Gowers in 1904 He offered no evidence, but his bare statement was accepted for forty years until this concept was challenged for the first time this century in an article in the *Lancet* (Cyriax, 1945) Since then fibrositis has been divided into primary and secondary This is a separation with which I am in the fullest agreement, for in my opinion primary fibrositis is an imaginary disease and secondary fibrositis is a real entity

PRIMARY FIBROSITIS

Controversy has gone on for many years about the nature and identity of the different disorders by common consent included under this heading The existence of fibrositis is affirmed by most clinicians and denied by most pathologists, but, in the absence of an alternative explanation for the symptoms, purely negative views have so far carried little weight.

It is one of the purposes of this book to draw attention to the ready solution to the problem, whether or not fibrositis exists, that can be obtained by going back to first principles This involves taking a detailed history, making a clinical examination of the patient and drawing deductions on accepted lines from the physical signs discovered in each case. If this is done, the conclusion is forced upon the unprejudiced observer that the symptoms so readily ascribed in the past to "rheumatic fibrositis" (*i.e* fibrositis coming on for no apparent reason) are all in fact the result of articular lesions. I say "unprejudiced observer" advisedly, for I started my professional life as the very reverse. As a student, I had been taught that rheumatic fibrositis was common, and led to pain and nodule-formation caused by non-specific inflammation in the myofascial tissues of the trunk and

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NON-ARTICULAR RHEUMATISM AND FIBROSITIS

"Non-articular rheumatism" is best translated as "pain not coming from a joint" Since the structures about a joint are all named, a proper diagnosis would single the affected tissue out. The phrase has no diagnostic significance and should be abandoned

Readers of this book will be invited to consider the physical signs found present on clinical examination of patients with "fibrositis" and to draw deductions on standard lines set out in Chapter VI. If they carry out these procedures, they will be forced to conclude, as I have been in patient after patient with symptoms ascribed to fibrositis or to non-articular rheumatism, that there is no such thing as primary acute or chronic rheumatic inflammation of soft tissues. This fact is amply born out by post-mortem experience. Many pathologists have sought for evidence of "fibrositis" after death, and though there is hardly a patient in the country who has not had this label applied to one or other of his symptoms, no evidence pointing to the real existence of primary fibrositis has ever come to light. Indeed, the conditions once ascribed to such inflammation in the soft structures of the body, *e.g.* acute torticollis, pleurodynia, lumbago, can be shown by proper interpretation of the physical signs present to result from internal derangement of a spinal joint. The pain is felt "in the muscles"; tenderness, crepitus, nodule formation may even be found at or near the site of pain as well as elsewhere; nevertheless such

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limbs. This idea was so firmly rooted in my mind that it is only during the last ten years that I have been able to convince myself that the condition is a misnomer and has no real existence. My error resulted from lack of appreciation of the meaning of ordinary physical signs. Doubtless others besides myself suffer from over-long persistence of beliefs inculcated during student years; they too must consciously divest themselves of preconceptions before they reach a position from which to study the problem afresh and to draw correct deductions from the signs demonstrated by clinical examination.

SECONDARY FIBROSITIS

There is no important controversy about the existence of four categories of this disorder: traumatic, rheumatoid, infectious and parasitic.

1. *Traumatic Fibrositis*

This is a synonym for a painful scar. The cause may be overuse or a single strain. Perhaps the best example is a tennis-elbow. A minor rupture occurs at the origin of the common extensor tendon from the lateral humeral epicondyle. Very little aching is set up at first, but, as the result of the torn edges beginning to join and then being pulled apart again each time the muscle is used, excess scar tissue is laid down in the healing breach. Within one to three weeks the elbow has become quite painful from the development of chronic traumatic fibrositis at the site of the tear.

Scarring in an intercostal or in the gastrocnemius muscle, golfer's elbow, teno-periosteal lesions at the wrist, crepitating teno-synovitis caused by overuse, abnormal scarring binding down a ligament after a sprain, capsular adhesions at the shoulder after injury—all these and a number of other similar conditions can well be regarded as caused by post-traumatic fibrositis: more exactly, fibrosis. Ischæmic contracture, since the fibrosis affects the whole of the muscle equally, does not cause chronic pain.

2 *Rheumatoid Fibrositis*

Rheumatic inflammation occurs, of course, in rheumatic fever and chorea. A similar type of inflammation has been found in rheumatoid arthritis. In the U.S.A Curtis and Pollard (1940) carried out biopsies on skin and muscle from patients with this disease and showed that small foci of round cells of the chronic inflammatory type were present. In 1942 Freund *et al.* demonstrated similar nodules on the nerve sheaths. In England, Gibson, Kersley and Desmarais (1946 and 1948) confirmed these findings, and further proved that they were absent from patients suffering from spondylitis deformans They showed that local degenerative changes affected the axons and medullary sheaths of the nerves close to these lesions, they also demonstrated an increase in the interstitial connective tissue accompanied by extreme thinning of muscle fibres. These findings were once more confirmed by Morrison *et al.* at Harvard in 1947 There is thus no doubt that *rheumatoid* inflammation affects a number of the fibrous tissues of the body This is in full accord with clinical findings, which show that, in addition to the joint lesions, the tendon sheaths thicken the tendons become rough and nodular (particularly in the palm), and bursæ swell and fill with fluid ' The inference may be drawn that rheumatoid arthritis is a generalized affection of the fibrous tissues of the body in which the chief and most obvious incidence is on the capsule of the joints" (Cyriax, 1947)

3 *Infectious Fibrositis*

Epidemic myalgia (Bornholm disease) is an infectious disease the virus of which has been identified It is characterized by fever severe pain in the abdominal and thoracic muscles, and speedy recovery

4 *Parasitic Fibrositis*

Infestation with *Trichina spiralis* sets up fever and painful swelling of the affected muscles, the skin over which may become red. The tendons may also be invaded The disease

comes on some ten days after eating infected pork. Active contraction of the affected muscle increases the pain. The symptoms and signs subside in the course of some weeks, and the patient becomes completely unaware of the foreign bodies in his muscles

GENERALIZED FIBROSITIS

Rheumatoid arthritis is the only condition to which the term " generalized fibrositis " properly applies. By contrast, the disorder to which this name is often given is multiple disc-degeneration at the spinal joints. This may lead to considerable aching over part or the whole of the trunk—areas where it so happens that muscular crepitus and fatty nodules are commonly detectable. Unrecognized osteitis deformans or spondylitis deformans is repeatedly called fibrositis.

Another disorder often called " generalized fibrositis " is psychoneurotic pain. The idea of generalized fibrositis has led to such concepts as diffuse " non-articular rheumatism " and " the psychological basis of rheumatism "—notions in which the cart is put before the horse. Clearly, psychogenic pain is not rheumatism, and the discovery of the real cause should lead to revision of that ascription, not to an attempt to fuse two incompatible diagnoses.

REFERRED TENDERNESS

This phenomenon forms the factual basis for the mistaken concept of " fibrositis." The two most vocal sponsors of " fibrositis " and " non-articular rheumatism " (Bach and Copeman) have defined it respectively as : apparently causeless pain in the deep tissues, and pain felt in the soft tissues associated with tenderness. Even as lately as 1951 Heald states that the sign of fibrositis is localized tenderness corresponding anatomically with the symptoms. Evidently the concept of examining a muscle by testing its function has not so far gained much ground in the country of its origin.

Referred tenderness is a particularly prominent symptom in lesions affecting nerves and is not necessarily associated with any cutaneous hyperæsthesia. For example, in more

than half of all cases of sciatic nerve-root pressure, genuine deep unilateral tenderness of the gluteal muscles on the affected side is easily revealed on palpation. Any structure in which pain is felt, even if it is merely referred pain, may become tender. On the other hand, the symptoms are not increased when the painful (and therefore tender) parts are put into vigorous action. The only way, therefore, to avoid the pitfall of eliciting tenderness at the site of a pain and regarding this as confirming a local origin for the symptoms is by the use of the diagnostic movements set out in Chapter VI. By this means alone can the examiner ascertain the area within which the lesion must lie and avoid being misled by referred tenderness.

Electromyography has shown that lower motor neurone lesions lead to fasciculation in the relevant muscles. Elliott (1944) hoped that this phenomenon might explain the referred tenderness so frequently present in spinal nerve-root compression. In the case of sciatica the facts fit quite well, for the tenderness is usually found in the gluteal muscles (which are derived from the correct roots). But at the neck in seventh cervical root-compression, the tenderness lies in the trapezius, levator scapulæ or spinatus muscles, none of which are supplied by this root. Electromyography reveals that, as would be expected, the scapular and vertebro-scapular muscles are free from fasciculation in a disorder at this level; hence referred tenderness cannot be correlated with the muscular fasciculation due to partial denervation.

Various efforts have been made to relate referred tenderness to metabolites formed locally as the result of nervous impulses—notably by Weddell, Sinclair and Reindel. That no such reaction occurs is demonstrated clearly by watching the changes in an area of referred tenderness during manipulative reduction of a displaced portion of cervical disc. To start with, the patient has an area of tenderness which he fingers himself and regards as the source of his symptoms. As reduction of the displacement proceeds, this area may move suddenly from place to place; as a rule the pain felt in the arm and scapular area transfers itself closer towards the midline of the trunk and moves from the upper thorax towards the lower neck. The tenderness follows the pain, and a spot felt to be tender a minute ago has now entirely

ceased to be painful on pressure, but another tender spot has appeared in a new position. Clearly metabolites produced locally could not come and go like this in the space of a few seconds.

The best explanation that can be offered of referred tenderness is that of superimposition of one pain on another. The area is felt to hurt. As the result of pressure applied locally, the spot hurts more—more than when equal pressure is applied to the symmetrical structure on the other side of the body. Summation of two pains, one referred, one local, has led to tenderness. This concept does not explain the reverse phenomenon—namely that gentle touch or stroking applied to the skin over an area of referred pain usually diminishes the symptoms.

NODULES, LOBULES AND MUSCULAR CREPITUS

Nodules, called fibrositic, are frequently found in the subcutaneous tissue of middle-aged persons. They are common in the lower lumbar and upper gluteal regions, often grouped about the crest and posterior superior spine of the ilia The outer aspect of the thigh may be affected as well. Their appearance may coincide with an increase in the patient's weight. These nodules feel like fibro-lipomata, the larger often being characteristically lobulated Clearly these nodules have nothing to do with "rheumatism" or with "fibrositis," their appearance merely coinciding with the onset of middle age. They are tender to pressure and occur in areas at which symptoms are often experienced, thus serving to distract attention from the actual source of patients' pain.

Copeman and Ackerman (1944, 1947) have shown that nearly everyone possesses fatty lobules in the substance of the lumbar extent of the sacrospinalis muscles They give rise to localized tenderness, present whether the patient has symptoms in their vicinity or not. Copeman still maintains (1949) that transfascial herniation is a pathological condition giving rise to pain. Examination of patients on the lines described in Chapter VI serves to dispose of this idea, for the clinical signs present are inconsistent with the diagnosis of a muscular lesion. Were such herniation to cause symptoms,

the patient would instantly relieve all tension on the sacrospinalis muscle and the lumbar fascia by lying down in full trunk extension. In this position the muscles and fasciæ are fully relaxed and any strangulation present would cease Since bending backwards is usually the most painful movement in lumbago, this hypothesis does not hold water

It is true that nodules have been searched for and treated by generations of physiotherapists, thus the idea that these structures and muscular crepitus are harmless and symptomless will doubtless take many years to establish It is therefore of the utmost importance that medical men who teach or employ physiotherapists should disabuse them of this erroneous notion—still taught today—in order that they may not waste their own and their patients' time in treating innocent structures

When it became clear that localized fatty lobules in the fascia or muscles had no pathological significance, I turned for evidence of fibromyositis to stringiness and crepitus felt when the examiner's finger was drawn across a muscle. But it was puzzling to find (Cyriax, 1041) that these "signs" persisted unchanged when patients' symptoms had abated The answer is obvious now, crepitus is a normal phenomenon most easily elicited at the deep lumbar fascia and the deeper layer of the paravertebral muscles of the lower neck and thorax. It has nothing to do with symptoms experienced in this area, though the pain that the patient experiences is often exactly reproduced by the pressure required to elicit the crepitus. Symptoms once ascribed to "rheumatic fibromyositis," *i.e* muscular pain coming on for no apparent reason, are shown by the physical signs, when these are properly looked for (Cyriax, 1948), to result from articular disorders.

Myosynovitis is a rare condition resulting from overuse Coarse crepitus is a normal finding at many muscles when palpated by a finger moving transversely By contrast fine crepitus felt by the stationary finger on active contraction of the muscle is a pathological finding It is found at the forearm and the leg

MUSCULAR SPASM

Spasm is the mechanism by which muscles are made to protect a painful structure. It is very marked about a broken bone, keeping the fractured ends motionless; about an inflamed joint, whose capsule is thus preserved from stretching; and in irritation of the sheath of the sciatic nerve-roots, hindering pull on them. Muscular spasm, leading to rigidity, is one of the most obvious signs of intra-abdominal inflammation of any severity, and spasm of the muscles of the chest may occur in intrathoracic disease, though in these two cases its influence towards diminishing mobility of the structure at fault is very slight. This spasm is quite painless. The patient's symptoms arise from the lesion, not from the secondary muscle spasm. This is obvious at, say, the knee, wrist or ankle where the joint is some distance from the muscles that fix it; but not at all so evident at, say, the shoulder or lumber region where the muscles overlie the joint.

Muscle spasm leading to limitation of movement may persist long after its usefulness to the individual has ceased For example, limitation of movement at the shoulder may necessitate manipulation of the joint under anæsthesia. If, as a result, lasting increase in the range of movement is secured, it is clear that the muscle spasm, however useful it was at one time, had out-lived its purpose. It is my view that one of the results of deep-seated inflammation is spasm of the muscles about that part. It is a result that may or may not be useful, according to circumstances, but it is as much a concomitant of inflammation as the classical heat, redness, swelling, pain and impaired function.

The muscles are not in constant spasm about an inflamed joint. They go into spasm when any extreme of the possible range is reached. So long as the joint is at rest, or is moved within the painless range, spasm is absent.

The muscles in spasm about a painful focus are not appreciably tender. The only exception is when the painful focus which a muscle is protecting lies within itself. If a few fibres of a muscle have recently parted, movement induces localized spasm about the lesion, preventing it from being over-stretched. Even then, it is at the minor rupture, not at the area of muscular spasm about it, that the tenderness lies.

It is not the muscles that are tender over an inflamed appendix or about an arthritic joint, it is the appendix or joint capsule that they are shielding in which the pain and tenderness lie. This distinction is not obvious at, say, the lumbar region and shoulder, but when one considers arthritis at the knee, the ankle, the wrist or the fingers—areas where joint and muscle do not overlap—it is clearly only the joint that is tender

If the appropriate resisted movement hurts, but not otherwise, localized tenderness picks out the site of the lesion The cause of this tenderness is certainly not spasm, for many other structures incapable of spasm *e.g* tendon, ligament and bone, are likewise tender at the site of a lesion. This is a vital point, bearing directly on practice. It is my view that the treatment of muscular spasm is that of the lesion to which it is secondary, whereas the treatment of a localized muscular disorder must be directed to the affected part of the muscle. If such localized lesions are regarded as due to spasm, analogy readily leads to the conclusion that the treatment of muscular spasm should be directed to the muscle I look upon this idea as wholly false and engendered by loose nomenclature. A clear distinction must, therefore, be drawn between the painless muscular spasm that springs into being to protect an inflamed structure and the pain set up on resisted contraction that characterizes a muscular lesion. Only in the latter case can any localized muscle tenderness be regarded as relevant. Muscular spasm never of itself requires treatment, since the only manner of ensuring its subsidence is the relief of the lesion to which it is secondary

The most striking example of the lengths to which the advocates of muscle spasm go is lumbago In acute lumbago the lumbar spine is seen to be held in *flexion*, allegedly by spasm of the sacrospinalis muscles—muscles that extend these joints!

Prolonged overuse can bring on localized areas of spasm—*e.g* of the adductor muscles of the thigh, during riding for the first time after a long interval. In such a case the whole muscle is tender and painful on use, and attempted contraction sets up twitching Such twitching in a fatigued muscle affects only a small part at a time, and the area of contraction can be seen to move along the muscle locally rather like a ball. The muscle does not shorten appreciably

as in cramp. The combination of tenderness and an area of spasm in this type of case must not lead to the idea that spasm necessarily or usually causes pain in and tenderness of the affected muscle. *Indeed, the existence of spasm of all the muscles about a joint indicates that the muscles themselves are normal but that an articular lesion of at least some severity is present.* Had this fact been clearly appreciated lumbago would never have been ascribed to a primary muscular lesion. When the knee-joint is suddenly and painfully locked in flexion, though the limitation of extension is maintained by spasm of the hamstrings, an attack of internal derangement is generally considered to have occurred. When the same event is reported at the lower lumbar spine, and spasm again fixes the joint in flexion, the cause should be sought in the joint, not the extensor, or even the flexor, muscles.

Muscular spasm is apparently of central origin. It is abolished most easily by general anæsthesia, acting on the cerebrum. Local anæsthesia induced at the site of the lesion, by abolishing afferent impulses, has the same effect, *e.g.* full straight-leg raising after epidural local anæsthesia in low lumbar disc-lesions. Riddoch's (1941) observations on phantom limbs showed that if pain was present, the patient stated that in his imagination he was unable to move his phantom limb, whereas in the absence of pain good subjective mobility was present. This shows that inhibition of movement can result from a purely cerebral process ; hence muscular spasm —the mechanism by which such immobility is brought about —can clearly be initiated cerebrally also.

MUSCLE TONE

Postural Tone. Feldberg (1951) points out that acetylcholine is released not only as the result of a nerve-impulse, but also continues at a very low level when the muscle is at rest. So long as the mechanism for the destruction of acetylcholine is intact the amount liberated is too small to cause muscular contraction and the electromyograph cannot therefore detect its presence It is not improbable that this phenomenon is more marked in trained than untrained muscle ; tone may well be affected by variation in the subliminal level of acetylcholine production. In mammals it

appears that tone is served by what is now known as the small motor nerve-fibre system The anterior roots have long been known to contain a distinct group of small diameter fibres (Eccles and Sherrington, 1930), as well as the well known large fibres. The function of this system remained unknown for a long time, but has recently been shown to serve the maintenance of sustained muscular contraction. It is thus very probable that future research will show that this is the system by which postural tone is maintained throughout the body

Athletic Tone Electromyography has demonstrated that the concept of muscle tone as a state of slight neurogenic sustained muscular contraction is false This is not surprising, for training increases what used to be called tone Obviously if use of a muscle led to its relaxing less readily than before, training would defeat its own object. Training clearly enhances the function of muscle, i.e it contracts *and* relaxes more efficiently

This fact has an important practical bearing For example, if a patient suffering from the thoracic outlet syndrome is given exercises to the elevator muscles of the scapula, no advantage accrues, for however strengthened these muscles become, they relax perfectly as soon as voluntary movement ceases and the scapulæ occupy the same position as before

The change perceptible when a muscle becomes stronger is in consistency Training enhances tone, *i.e* firmness to the touch, and does so in my view, merely by an increase in size of every fibre. The greater bulk of the muscle distends its fascia, hence the muscle feels harder Conversely disuse leads to a diminution in bulk, in consequence the muscle feels flabby because its individual cells are shrunken

NEUROGENIC HYPERTONUS

Muscular spasm secondary to painful lesions is unconnected with the hypertonus that accompanies neurological disease. In the former case, when movement is kept limited at a painful joint, such mobility as exists is painless, but at a certain point muscular spasm brings it to an abrupt stop beyond which no forcing, without anæsthesia, can take it.

By contrast, neurogenic hypertonus results in an early resistance to passive movements until, suddenly, the tone of the muscles is overcome and a full range of painless movement is revealed.

Cramp in the muscles of the lower limb is an unexplained phenomenon. It is common in healthy persons, and the site of pain is usually in the calf or foot; the foot and toes being painfully held in full flexion or full extension. The disorder is unconnected with tetany, but is apt to affect the calf muscles on the same side as a past attack of sciatica, and is a common sequel to a posterior radicotomy at the fifth lumbar or first sacral level. The fact that several muscles of one limb are affected in a co-ordinate way suggests a nervous ætiology; it may be the result of a discharge of impulses from the spinal cord analogous to the mechanism of epilepsy. Certainly, in cramp, it is the muscles that hurt. Cramp does not affect a muscle spontaneously; it is brought on by a voluntary contraction. Hence patients soon discover that it is most quickly abolished by passively stretching the affected muscle.

MENOPAUSAL ARTHRITIS

This is another condition which I regard as a misnomer. Women develop a number of painful disorders at one joint or another between, amongst other times, the ages of forty and sixty. These disorders do not differ from the same conditions occurring at other ages, or in men. In fact the commonest condition to which the label menopausal arthritis is erroneously applied is an impacted loose body in the knee-joint.

In my view it is not reasonable to label a condition menopausal unless it occurs only in female patients only at the climacteric, and I for one have been unable to identify any joint disease peculiar to this sex and this epoch.

PANNICULITIS

Rheumatologists believe in this condition, but I do not regard it as a possible cause of pain. In middle-aged women symmetrical fatty deposits develop, especially at the buttocks

and thighs They lie just under the skin, superficial to the muscles Should, by chance, pain in the buttocks or thigh come on in such a patient the association of pain with the presence of sensitive deposits in the same area can deceive, but only if the examiner relies on palpation alone. If he finds, as is to be expected, that some movement of the trunk or limb affects the pain, he knows that the pain arises from a moving part. Fat lying between skin and muscle cannot interfere with movement, as examination of the other limb—equally tender but painless—will show Nor can it give rise to referred pain, for it lies too superficially

Panniculitis should therefore be considered as a possible cause of symptoms only if the function of the affected area is found fully normal But patients with normal function do not complain of these painful deposits except for cosmetic reasons Hence I cannot see on what grounds they are supposed to cause symptoms

FOCAL SEPSIS

This concept still lingers on but should be forgotten at once. Since the ætiology of rheumatoid arthritis is not known, it is as undeniable as it is unaffirmable that this disorder may have some such cause, and there is always the undoubted fact that gonorrhœa does produce joint lesions at times indistinguishable from rheumatoid arthritis. But it has repeatedly been shown that focal sepsis is not more prevalent in sufferers from rheumatoid arthritis than in the population at large, *and excision of such local foci as may be found certainly* does not bring about recovery from rheumatoid arthritis more often than occurs spontaneously

After all, most middle-aged and elderly patients attending London hospitals harbour gross dental sepsis, but do not on that account suffer from arthritis any more than do the edentulous or those who have had their tonsils removed nor do those who suffer even from chronic osteomyelitis and secondarily infected tuberculous abscesses, even if they eventually develop amyloid disease *Rheumatoid arthritis* may start in patients from whom teeth and tonsils were removed years previously When the advocates of focal sepsis are baulked in the oral cavity they fall back on the

abdomen, the appendix and gall-bladder in particular. If nothing is found there, intestinal stasis may be invoked, though happily not so often as formerly. In this connexion a most cogent epitaph is provided by the following extract from the leading article in the *British Medical Journal* (June 23rd, 1945) which sets the matter in a nutshell.

"It was not so long ago that we all believed in the evils of intestinal stasis, with its 'auto-intoxication' due to the supposed absorption of hypothetical bacterial toxins. The bacterial inhabitants of the intestine are no longer looked upon as toxin-producing parasites but as useful symbiotic organisms breaking down unwanted waste products such as cellulose and unabsorbed nitrogenous matter, and synthesizing, among other things, numerous vitamins and also protein."

The recognition of the articular provenance of what used to be called fibrositis has exposed, of course, the futility of looking for causative focal sepsis.

VACCINES

These are wholly inactive in any of the conditions that used to be called "rheumatism." There is no acceptable evidence that any disease (with the single controversial exception of furunculosis) caused by a known bacterium can be cured by use of the appropriate vaccine. Vaccines have their chief value in prophylaxis. It is, therefore, in the highest degree sanguine to trust that vaccine therapy will modify the course of a disease when (*a*) there is no real evidence that this is the result of bacterial infection; (*b*) even if it were, there is no evidence that vaccines would help and good reasons to be drawn from analogy to suggest that they would not; (*c*) the vaccine is made from bacteria, whether autogenous or from stock, that have not been shown to cause arthritis in human beings. I worked for over a year at a clinic at which vaccines were injected with the intention of benefiting patients with rheumatoid arthritis, osteo-arthritis, prolapsed intervertebral disc, spondylitis deformans and muscular lesions alike, and my experience there confirmed me in this view.

CHAPTER II

TRAUMATIC INFLAMMATION

IT is becoming increasingly clear that the reaction of the body to noxious stimuli, whatever their nature is the same. Physical and chemical agents set up the same stereotyped inflammation as bacteria Menkin's series of experiments has left no doubt on this point.

The excessive reaction of tissues to an injury is conditioned by the over riding needs of a process designed to limit bacterial invasion If there is to be only one pattern of response, it must be that suited to the graver of the two possible traumata. However a process intended to wall off a noxious agent clearly has no value in traumatic inflammation It follows that this elaborate preparation for preventing the spread of bacteria is not only pointless after an aseptic injury but so excessive in degree as in itself to prove harmful Indeed the principle on which the proper treatment of recent post traumatic inflammation is based is that the reaction of the body to an injury unaccompanied by infection is always too great. The most recent view of inflammation now generally accepted, is that the noxious agent plays a smaller part in maintaining the defensive reaction than the products elaborated by the injured tissues themselves These increase capillary permeability and encourage diapedesis of leucocytes reactions of no advantage in an aseptic injury Obviously local or distant œdema also has no virtue in hastening the healing of a tear on the contrary, since the tension it exerts causes pain and impedes movement, its effect must be damaging Fluid in the joint obviously does no good either The hindrance to movement set up by muscular spasm to the degree that often occurs is of no value If the spasm were confined to protecting the torn structure from further overstretching it would be useful but in fact it is great enough to cause much limitation of movement at the joint. This, too, is harmful for resolution of inflammation—with inevitable fibrosis—then takes place in the absence of adequate movement.

REST AND PAIN

An important landmark in medical history was the appearance, in 1863, of Hilton's book on the value of rest in the treatment of pain. This book has held sway over medical thought until very recently, though perusal shows that nearly all the cases on which Hilton based his recommendations would now be recognized as tuberculous. When pain is in fact due to bacterial inflammation, Hilton's advocacy of rest remains unchallenged and is today one of the main principles of medical treatment. When, however, somatic pain is caused by inflammation not due to bacterial action, his ideas have required modification. When non-bacterial inflammation attacks those soft tissues that move, treatment by rest has been found to result in chronic disability later, though the symptoms have diminished for the time being. Hence, in the course of the present century, treatment by rest has given way to therapeutic movement in many soft tissue lesions. Movement may be applied in various ways: the three main categories are (1) active and resisted exercises; (2) passive, especially forced, movement; (3) deep massage.

Hilton spoke of pain generically; whereas inflammation causing pain is nowadays divided from the point of view of treatment into that which *is* caused and that which *is not* caused by bacteria. In either case it is pain and loss of function that the patient himself experiences; for the symptoms of, say, a bacterial or an infective or a traumatic arthritis may be identical. Hence the patient cannot decide for himself whether his pain is due to a lesion requiring rest or movement for its alleviation. How can he understand that a sprained shoulder should be moved, but a sprained elbow or back rested? Or that a sprained ankle should be walked on, but a subacute traumatic arthritis of the tarsus immobilized? Indeed, a patient normally takes the view that pain is Nature's danger signal, and regards any activity that causes pain as harmful. This theorizing is perfectly logical, sometimes correct, sometimes not, even when it is to all appearances borne out when he finds that avoidance of activity results in immediate relief. Once more the false conclusion is reached that rest is the treatment of all pain.

It is only the medical man who can decide whether the patient's symptoms arise from a lesion requiring treatment by rest or by movement.

TREATMENT OF TRAUMATIC INFLAMMATION

The aim of treatment in non specific inflammation of moving parts is the formation of a strong and *mobile* scar, of static parts, the attainment of strong *immobile* union. Thus, in the former case, healing must take place in the presence of movement in the latter case, in the absence of movement. In the case of a joint or a muscle, therefore, treatment is designed to reduce the normal reaction in the injured part to as small proportions as possible, the patient being encouraged to ignore whatever discomfort remains In the case of bone on the contrary firm union is encouraged by immobilization of the fracture, care being taken that movement elsewhere is interfered with as little as possible

THE HORMONE TREATMENT OF RECENT INJURY

As has already been stated, the reaction to an injury tends to be both greater and more prolonged than is required merely for the proper healing of the damaged tissue. Any simple method of diminishing the intensity of post-traumatic inflammation is therefore most welcome.

The results of experiments carried out by Selye in Canada during 1946 to 1949 strongly suggest that such a remedy exists in cortisone. Selye injected formaldehyde under the plantar fascia of rats, thus provoking an immediate inflammatory reaction Especially when several injections were given, the rat developed a swollen, tender and painful ankle-joint, which continued to get worse long after the injections had ceased Clinically and histologically this disorder resembled human rheumatoid arthritis

If the animals were injected with cortisone or ACTH at the same time as the formaldehyde was introduced, the local reaction resolved much more quickly and the supervention of chronic arthritis was almost completely inhibited. Little doubt therefore exists that an excellent treatment for recent soft tissue injury is to abate the inflammation at once by

division and suture in the course of an operation. As regards muscles, therefore, it is not so much the existence of diffuse fibrosis or of one thick scar with normal tissue on either side of it, as localized areas of microscopic adhesion that appear to cause symptoms. The explanation may be sought from the fact that small scars within the elastic tissue result in local variations in tension when the muscle contracts, pain resulting from over-stretching at the junction between normal muscle and scar tissue. Such local variations in tension do not arise if the scar reaches right across the muscle belly or if the whole muscle is diffusely affected, *e.g.* in ischæmic contracture. The pull on the muscle is then evenly distributed.

Once the full capacity to broaden has been restored to the muscle by friction or infiltration, active exercises should be employed to maintain the added mobility thus secured. By contrast to their usefulness in articular injury, passive movements are valueless in the treatment of muscular injuries; resisted movements should be begun cautiously only when healing is well advanced, so as to avoid excessive strains that might lead to further rupture of fibrous tissue in the process of consolidation within the muscle.

Rehabilitation by the patient's unaided efforts, while yielding slow but eventually good results in the treatment of some injuries to the bellies of the muscles of the limbs, may prove unavailing when other muscles are affected. For example, no amount of exercises can free fibrosis in an intercostal muscle, in a muscular tennis-elbow or in an interosseous muscle; deep massage, however, is lastingly curative. Again, at its point of insertion into bone or tendon, exercises cannot mobilize a muscle adequately. Thus the employment of deep friction is useful in proportion as the local play of the muscle fibres is small.

Myosynovitis

This appears to be the best name for acute traumatic muscular pain and crepitus on movement. In severe cases, crepitus may be felt over a large extent of muscle belly (Cyriax, 1941). It occurs in the upper limb in the extensor muscles of the forearm. In the lower limb it is found in

connexion with the tibialis anterior muscle only Where the lower part of the belly lies in contact with the lateral aspect of the lower tibia, overuse causes a small area of crepitus on movement. Massage is quickly curative.

TENDINOUS LESIONS

Tendinous lesions have six sites roughening of the gliding surfaces of a tendon in its sheath (teno-synovitis), painful scarring in the body of a tendon (tendinitis), painful scarring at a teno-periosteal junction, painful scarring at the musculo-tendinous junction primary thickening of a tendon sheath (teno-vaginitis), a spindle-shaped enlargement of the tendon that jams in the sheath

Teno-synovitis

This is a primary lesion of the gliding surfaces of the external aspect of a tendon and the internal aspect of a tendon-sheath. Pain is set up as the roughened surfaces move against each other, if the disorder is at all severe, crepitus is clearly palpable. Fine crepitus results from teno-synovitis caused by overuse coarse crepitus characterizes that due to rheumatoid disease or tuberculosis (not dealt with below)

The principle of treatment is to restore painless movement of the tendon within its sheath. This can be attained in three ways (1) by injection of hydrocortisone, (2) by slitting the tendon sheath, and (3) by deep massage. Immobilization was tried but is so slow cumbersome and uncertain in its results that its use is seldom indicated The second method enlarges the sheath, thus bringing about immediate cure. Since the sheath no longer fits the tendon closely the roughening ceases to matter Most patients, particularly women, when offered the alternative between operation and deep massage—each equally certain in its result—elect treatment by massage, if only to avoid the scar Deep friction is therefore generally preferred, since it is quick and reliable and saves the patient admission to hospital or from having to wear a more or less cumbersome splint. During friction the inner aspect of the sheath is moved repeatedly to and fro across the surface of the tendon and the surfaces are smoothed off

By contrast, rehabilitation by the patient's own endeavours is impossible. Since the cause of teno-synovitis is often overuse, obviously any sort of passive or active movement is valueless, and any resisted movement harmful. Indeed, if the causative strains are reproduced, movement serves only to maintain the inflammation. Until well, the patient must, so far as is reasonably possible, avoid all activities that cause pain.

Tendinitis

The function of tendons that do not possess a sheath is merely to transmit power from muscle belly to bone. For this purpose they must bear stress equally throughout their substance.

Strain occurs both at a teno-periosteal junction and in the substance of a tendon. Minor rupture occurs at either site followed by a small scar which often remains lastingly painful. Active exercises, however soon they are begun after an injury, cannot secure an even distribution of stress in tendons, for each time the belly contracts, the fibrous tissue in the process of formation is pulled upon in a longitudinal direction only. In a recent case such tension is apt to renew the rupture in the healing breach; later on, it irritates further the painful scar. It is a well-known fact that, for example, playing tennis repeatedly does no good to a tennis-elbow. Thus, exercises do harm in recent cases, and they are valueless in chronic cases since they are powerless to secure a strong scar that bears strain evenly throughout its substance. The treatment of choice in recent or long-standing cases is deep massage, which moves the tendon to and fro, thus allowing longitudinal fibrous tissue to remain intact but gradually wearing down transverse scarring. The alternative is infiltration with hydrocortisone, which renders the painful scar painless. Only in the case of a tennis-elbow has passive stretching a curative effect.

Nothing the patient can do, apart from the avoidance of such exertion as causes pain, has any value.

Teno-vaginitis

This is a primary lesion of the sheath of a tendon, usually with considerable thickening of the actual tendon sheath It may follow repeated strains but is often apparently causeless. In rare instances, rheumatoid disease, gout, gonorrhœa or xanthomatosis is responsible. Crepitus is never found in this condition

In non specific teno-vaginitis deep massage, hydrocortisone or operative incision of the tendon-sheath are each curative

Localised Tendinous Swelling

Any of the digital flexor tendons may develop a rounded swelling on its course in the palm or within the carpal tunnel. It may engage and become fixed within a constricted part of its sheath—the trigger phenomenon—or press on an adjacent nerve.

SPRAINS AT A JOINT

The function of a capsule of a joint is to hold the bone ends together while allowing free movement at the joint. Ligaments reinforce the capsule at points of special stress, they have a range of movement over bone that has to be maintained after a sprain. Ligaments are not appreciably elastic. Overstretching of ligaments leads to permanent, often painless, laxity those ligaments, the tension on which is not controlled by muscles, are particularly liable to such lengthening

In the treatment of injury to the soft tissues about a joint, the long view must prevail Clearly rest eases the immediate symptoms best, but at many joints it also ensures the diffuse consolidation of adhesions Thus the object of treatment in most articular sprains is (*a*) relief from pain, and (*b*) healing in the presence of movement. Naturally, relief from pain, apart from being an end in itself, provides the quickest way of obtaining satisfactory movement. In the past the former object was promoted by applying a cold wet bandage in so far as this was effective at all, it must have encouraged vasoconstriction in its neighbourhood A later development

of this idea—freezing the skin by means of an ethyl chloride spray—doubtless exerts the same reflex effect more strongly. Compression of the swollen part by adhesive strapping and the injection of anæsthetic solutions or hydrocortisone into the damaged area also serve in different ways to encourage function by mitigating pain.

The best way to apply treatment by movement varies from joint to joint. For example, at the knee, deep massage maintains mobility in a way that cannot be achieved by merely moving the joint; again at the tarsus, friction and movement afford better results than either of these alone. Capsular sprains at the shoulder should be treated by movement alone. At the elbow-joint, the treatment is rest. For sprains of the finger-joints, treatment is unavailing.

Recent Articular Sprain

moment for otherwise they develop into the strong fibrous scars (adhesions) that so often cause prolonged disability after a sprain

Contrary to general belief deep massage and passive movement are the mainstay of treatment during the early stage of articular sprains The present insistence on active movements alone greatly retards recovery at some joints Some ligaments, *e.g* the coronary ligaments at the knee, can be kept adequately moving only by the physiotherapist's finger It is the fact that the bone and ligament move in relation to each other that maintains mobility the agency is immaterial It is the muscles about a joint, not the joint itself that are differently affected by different types of movement, the ligament moves over the bone during a passive movement exactly as much as it does during an active movement of equal range. But a sprained joint can always be moved over a greater range passively than actively and the easiest and quickest way to secure good active movement is to show an apprehensive patient how great a passive range of more-or less painless movement his damaged joint possesses. Thus even if the orthopædic surgeon believes in active movements only, it is clear that passive movement—whether by means of deep massage or by gentle forcing of the joint—so greatly facilitates subsequent active movements that it should not be omitted on account of prejudice.

The strength with which gentle movements should be applied must strike a balance between an excess of vigour and an excess of gentleness The movements must not be so forcible as to overstretch those fibrils that are gaining longitudinal attachment within the healing breach, nor should they be so gentle as to fail to disengage those fibrils that are gaining abnormal transverse adherence. A safe rule is to push movements to the point of discomfort but not of pain All the possible movements of the joint should be attempted passively, one by one, and a definite increase in the range of movement should be achieved each day The patient then repeats these movements actively

This view must not be taken as suggesting that active movements have no value—on the contrary The muscles about a damaged joint lose tone and often waste they also require treatment. Hence resisted exercises should be begun

at the earliest moment. In cases of a severe sprain of a joint such as the knee, these exercises are at first best performed while the joint is relieved of bearing body-weight.

The principles of treatment depend on whether movement at a joint is or is not controlled by muscle

(1) *Joints at which Movement is under Voluntary Control.* During the first twenty-four hours after a sprain, the best treatment is local anæsthesia induced at the site of the ligamentous or capsular tear. Traumatic inflammation is reduced to a minimum and as far as possible structural changes are prevented from taking place. Since the reaction of the tissues involves the production of a local acidosis, a local anæsthetic which remains stable in an alkaline solution would have a neutralizing effect as well—an advantage over procaine hydrochloride. Hydrocortisone offers an alternative approach.

After a day has elapsed, local anæsthesia has lost its value in the treatment of joints, though it remains effective in the case of muscles. If there is œdema, effleurage diminishes swelling and pain, thereby lessening both local and voluntary obstruction to movement If the sprained spot lies within reach of the physiotherapist's finger, the short period of friction that is then applied here further decreases pain and moves the damaged structure to and fro over subjacent bone. Since there is no question of breaking down strong scars but merely of preventing young fibroblasts from forming unwanted points of adherence, the deep massage need last only a minute or two and should be as gentle as is compatible with securing adequate movement of the damaged structure. The physiotherapist then puts the damaged joint or joints through the greatest possible range of movement without causing appreciable pain. Active movements serve to maintain the movement thus afforded and to keep the muscles strong. Finally, by using the limb as normally as he can, the patient retains and increases the usefulness of the injured part

When a joint lies deeply, *e.g.* the shoulder-joint, the site of a capsular injury is out of fingers' reach Hence, in treatment, movement alone is possible : first passive, then active. As neither massage nor local anæsthesia can be used to facilitate movement at the site of such an injury, the practicable

adjuvants are hydrocortisone and if this is not available, deep heat (i.e short wave diathermy)

After the first few days, only the patient's own active endeavours serve to bring about recovery from many types of fracture and orthopædic operation It is doubtless by analogy with the uselessness of massage and passive movement in disorders of this type that the idea has arisen that they have little or no value in allied conditions.

(2) *Joints at which Movement is not under Voluntary Control.* These are the acromio-clavicular joint, the sterno-clavicular joint, the sacro-iliac joint, the sacro-coccygeal joint, the symphysis pubis, the collateral and cruciate ligaments at the knee, and the inferior tibio-fibular ligament.

Healing in the absence of enough movement need not be feared. On the contrary such capsular and ligamentous overstretching as may have taken place is apt to be permanent, though it is not necessarily a cause of symptoms The principle of treatment is then the avoidance, as far as possible, of movement by protection of the joint. If chronic pain supervenes, and the damaged fibres lie within fingers' reach, they are treated by deep massage Hydrocortisone is called for if the lesion is small enough for adequate infiltration.

Chronic Ligamentous Sprain

In these cases, adhesions were allowed to form because of inadequate treatment during the acute stage , they now limit the play of the ligament over bone Naturally the object of treatment is restoration of full painless mobility In addition, the power of the muscles controlling the injured part may require restoration. The manner in which treatment is carried out varies with the nature, position and toughness of the adhesions Forced movement frees adhesions about a joint. Mobilization may be required under general or local anæsthesia (most often at the knee and shoulder) under massage analgesia (often at the knee and tarsus) or under heat analgesia (fractional mobilization at the shoulder, hip and cervical spine) Massage analgesia can be used only when the ligament lies within fingers reach in addition to numbing the painful spot, scar tissue is thinned out as the ligament is moved to and fro over bone In certain situations

movement cannot be forced in any other way; for example, deep friction is by far the best way to mobilize the coronary ligaments and the ulnar collateral ligament at the wrist-joint. Active movements follow, reproducing the range of movement that has just been passively increased. Finally, resisted exercises are given to strengthen the muscles about the joint.

INTERNAL DERANGEMENT OF JOINTS

This phenomenon is far commoner than used to be supposed. At the knee-joint, quite apart from the well-known subluxation of a torn meniscus, another type of internal derangement, that caused by an impacted loose body, has lately been recognized as of frequent occurrence. At the elbow and wrist-joints internal derangement is not uncommon. Moreover, a large number of obscure pains at the trunk and limbs are now known to result from displacements within the intervertebral joints, quite apart from the fully developed syndromes of brachial neuritis and sciatica.

Great difficulty attends the differential diagnosis at the knee between infective arthritis and chronic internal derangement. In both cases, the joint may be swollen and warm to the touch. The methods of treatment in the two cases are diametrically opposed; hence the distinction has great practical importance.

Treatment varies from joint to joint, but in essence it is twofold:

(1) Inducing the displaced intra-articular structure to return to its bed. For this purpose manipulation is often required and may yield an immediate happy result. Many of the successes obtained by lay manipulators are susceptible of simple explanation on this basis. At the spinal joints reduction by sustained traction provides an alternative.

(2) The maintenance of reduction once obtained is equally important; for in all disorders caused by loose-body formation within a joint the liability to recurrence is naturally pronounced. Should reduction or its maintenance prove impossible, the question arises of operative removal of the loose body.

CHAPTER III

REFERRED PAIN

THE chief obstacle to arriving at a correct diagnosis in painful conditions lies in the fact that the symptom is often felt at a distance from its source. Diffusion of pain is a phenomenon common to all aspects of medicine, but in the strictly medical and surgical fields the pain is usually accompanied by constitutional signs that help to identify the lesion, or at least, give rise to unequivocal signs that some disease is present. In the disorders of soft tissues and joints with which the orthopædic physician deals the complaint is often merely of pain, local and general signs being conspicuously absent. The diagnosis in such cases turns on the assessment of the site and nature of the pain and the manner in which it is projected and elicited—in other words on a clear understanding of ' referred pain " and of the conditions favouring its reference. Moreover, this knowledge enables an otherwise misleading phenomenon to be turned to diagnostic advantage In deep-seated soft tissue lesions the symptoms are often very deceptive and usually lead to treatment being applied in the wrong place Such symptoms are very common among patients sent to an orthopædic physician

Pain felt elsewhere than at its true site is termed " referred " Familiar examples of pain perceived at a distance from its source are pain in the shoulder accompanying liver disease, pain in the knee in arthritis of the hip the sacral pains of childbirth, and pain in one or both arms in angina pectoris

Referred pain is an error in perception (Cyriax, 1941) On all previous occasions in the patient's lifetime, a stimulus reaching certain cells in the sensory cortex has meant to him that damage was being inflicted on a certain area of skin When the same cells receive a stimulus implying pain, naturally the sensorium interprets this message on a basis of past experience, *i.e* refers the pain to the area of skin connected with those particular cortical cells, for the skin is the only part of the body the patient is normally aware of.

The crucial experiment in this sphere was made by Sir Thomas Lewis in the autumn of 1936. Wishing to investigate muscular pain, he injected an irritant deeply into the lower lumbar region. He found that a diffuse pain running down the lower limb had been provoked and that the subject experienced little or no discomfort at the site of the injection. In 1938, Kellgren published the results of a systematic examination of the phenomena of referred pain, showing them to radiate segmentally and not to cross the mid-line.

Until this time, wide radiation of pain had been regarded as evidence of involvement of nerves, whereas this research showed that many soft tissues could be the source of such symptoms. Thus in order to approach the problem of referred pain with an open mind, the reader must consciously divest himself of the idea of projection of pain necessarily following a nerve. This idea has proved most tenacious in spite of the clear experimental proof that the pain is merely interpreted by the cerebrum as occupying part or the whole of an embryological segment. It has presented the chief obstacle to a logical approach to the problems which arise when the origin of a diffuse pain is sought. The source of this confusion may lie in the fact that the nerve-supply to all structures is distributed on a segmental basis. This arrangement by no means warrants the notion that pains are projected down nerves

There are many relevant clinical phenomena which any member of the medical profession can investigate for himself. One of the most common and obvious is a tennis-elbow. When pain from this lesion diffuses so far as the hand, it is nearly always felt in the long and ring fingers. No single nerve runs from the elbow with such a distribution, whereas this area represents the distal part of the seventh cervical segment. Rarely the pain is referred to the ring and little fingers; yet it is not conceivable that a lesion at the lateral humeral epicondyle could in any way affect the ulnar nerve. Again, down what nerve can pain diffuse from the subdeltoid bursa or the supraspinatus tendon to the arm and forearm? How can a posterior cervical pain radiate to the area supplied by the trigeminal nerve in the forehead? What nerve stretches from the heart or diaphragm to the arm, from the appendix to the umbilical area, from the shoulder-

joint to the wrist or from the sacro-iliac ligaments to the heel?

It might be argued that an axon reflex is involved and that sensory fibres carry the impulses to the cord, whence they are projected down the limb. Proof that this is not so is afforded by the fact that section of the supposed efferent trunk of this reflex does not affect reference of pain. Even amputation distal to the focus from which the pain starts is without effect, pains being felt to run along absent limbs. Destruction of the ganglion of the trigeminal nerve, for example, does not affect the patient's capacity to perceive pain in the forehead referred from the cervical joints. Myocardial and diaphragmatic pains are projected down an absent upper limb and pain may occur by reference in an area rendered anaesthetic on account of a peripheral nerve palsy. This finding was confirmed by Harman (1951) who found anginal pain in the arm to be unaltered by a brachial plexus block.

So far as the conditions dealt with in this book are concerned, the idea that pain originating in a somatic structure is referred distally via a nervous pathway must be abandoned. Indeed, no progress towards defining the site of lesions setting up distant pain will be made until Sir Thomas Lewis's teaching on these matters is accepted and applied to the clinical examination of patients.

THE SEGMENTS

Plates 2 and 3 give a general impression of the embryological origin of the skin (dermatomes) but do not allow for the overlap. This is so considerable that division of one posterior spinal root causes little interference with cutaneous sensibility, and the changes after the division of two adjacent roots are sometimes barely perceptible. These figures do no more than represent the central parts of each segment and indicate the type of arrangement. Much more accurate knowledge of the shape of each dermatome is required of the practitioner of orthopaedic medicine if he is to derive assistance in diagnosis therefrom.

The symptoms under discussion arise from deep-seated structures and transmit impulses to the cerebrum that are interpreted as *originating from that segment*. The *sensorium*

is concerned chiefly with skin sensation, and is thus concerned with the size of the dermatome rather than the size of the myotome

Since the dermatome is often larger than the myotome, pains may be felt to occupy an area more extensive than the myotome in which they arise. For example, the pain of supraspinatus tendinitis may reach the radial border of the hand, whereas the fifth cervical myotome does not extend below the elbow. Hence, *the extent of the relevant dermatome governs the distance that pain arising from any part of a myotome may travel.*

DERMATOMES

These vary somewhat in shape from person to person. Judging by the distribution of paræsthesiæ in known root-lesions in the neck, there are marked individual discrepancies. If, for example, patients with a cervical disc-lesion leading to a seventh-root paresis (as judged by the pattern of muscular weakness) are questioned on the site of the pins and needles that they experience in their fingers, some state that all five digits are affected ; some all the four fingers but not the thumb ; some the index, long and ring fingers ; some the index and long finger ; some the long and ring finger, and some only the index or only the long finger. Yet in each case the seventh cervical root is compressed. Hence, the deduction must be drawn that the distal cutaneous area supplied by one nerve root is very variable.

Foerster's (1933) painstaking work, however, accords very well with clinical findings and is, therefore, set out below in detail.

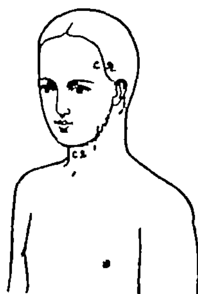
Cervical 1. Uncertain (Probably the vertical area of the skull.)

Cervical 2. The whole occiput, the chin and the medial parts of the front and back of the neck (Fig. 2).

Cervical 3. The entire neck, the posterior half of the mandible and the ear (Fig. 3).

Cervical 4. The shoulder area, the front of the upper chest, the lower half of the neck (Fig. 4).

Cervical 5. The shoulder, the front of the arm and forearm as far as the base of the thumb (Fig. 5).



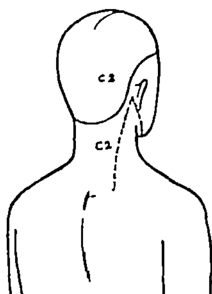


FIG. 2.—2nd cervical dermatome.

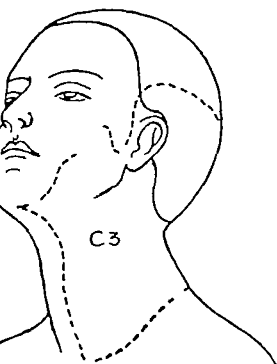


FIG 3.—3rd cervical dermatome.

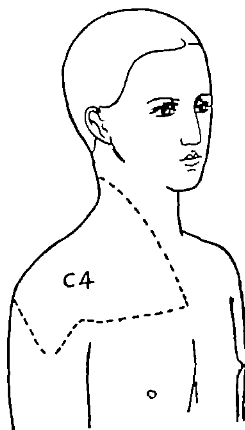


FIG 4.—4th cervical dermatome.

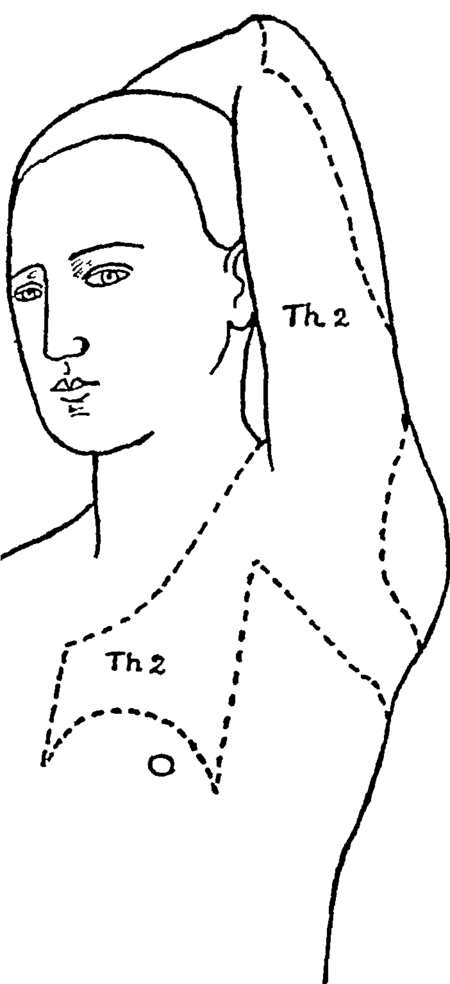


FIG. 9—2nd thoracic dermatome.

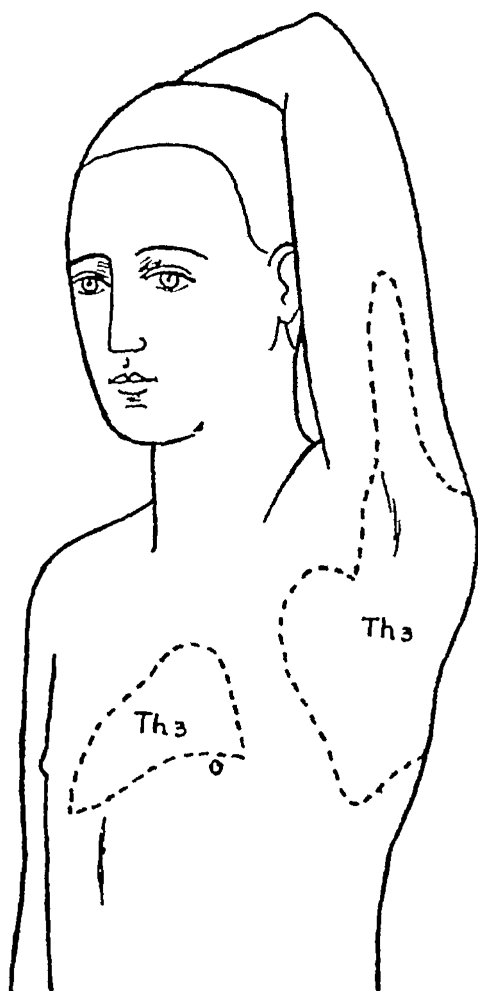


FIG 10—3rd thoracic dermatome.

Thoracic 4, 5, and 6. These encircle the trunk reaching the level of the nipple (Figs. 11 and 12).

Thoracic 7 and 8. These encircle the trunk reaching to the lower costal margin.

Thoracic 9, 10 and 11. These encircle the trunk reaching the level of the umbilicus (Fig. 13).

Thoracic 12. Uncertain (probably reaches to the groin).

Lumbar 1. The lower abdomen and groin; the lumbar region from the second to fourth vertebræ; the upper and outer aspect of the buttock (Fig. 14).

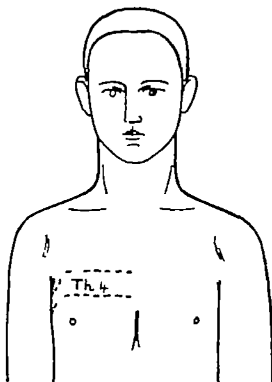


FIG. 11—4th thoracic dermatome.

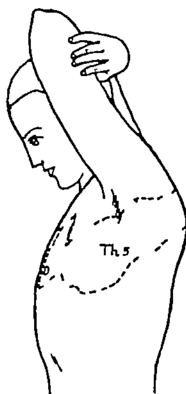


FIG. 12.—5th thoracic dermatome.

Lumbar 2 Two discontinuous areas The lower lumbar region and upper buttock (Fig 15) The whole of the front of the thigh (Fig 16)

Lumbar 3 Two discontinuous areas The mid buttock (Fig 15) The inner aspect (sometimes the front) of the leg as far as the medial malleolus (Fig 17)

Lumbar 4 The anterior and medial aspects of the leg according to Foerster the postero-medial part of the upper calf the medial side of the dorsum of the foot the whole hallux (Fig 18) N.B—Experience of the distribution of pain in fourth lumbar root pressure suggests that the dermatome occupies the outer rather than the inner aspect of the leg, crossing to the inner border of the foot at the tarsus

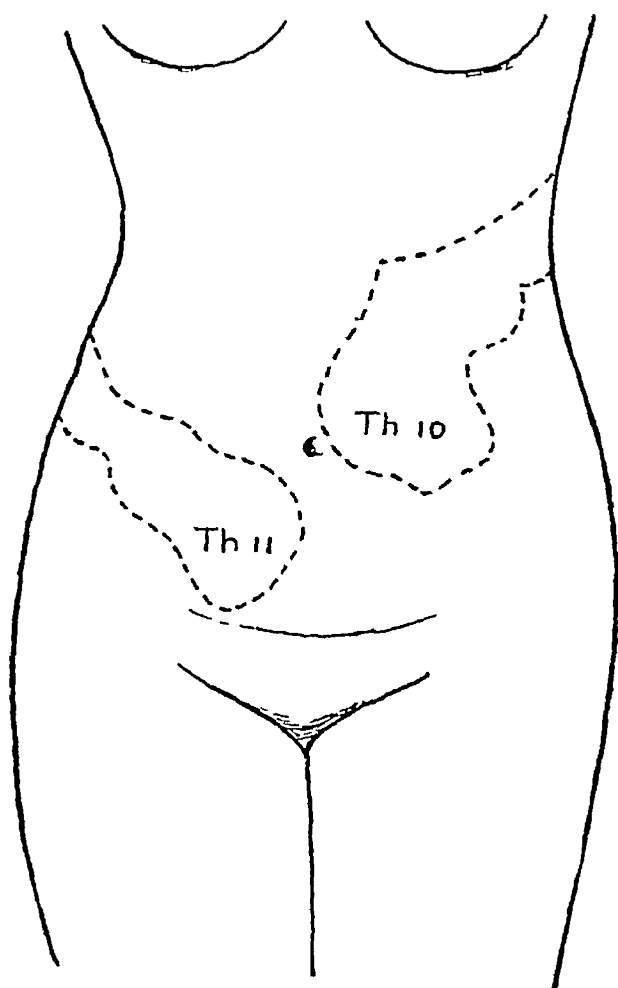


FIG 13—10th and 11th thoracic dermatomes

Lumbar 5. The outer aspect of the leg; the dorsum of the whole foot and the first and second toes (Fig. 19). The inner half of the sole (Fig. 19). N.B.—the fourth and fifth lumbar dermatomes are all but identical.

Sacral 1. The sole of the foot, the two, three or four outer toes and the lower half of the posterior aspect of the leg (Fig. 20). N B—During the treatment of chronic sciatica Sicard and Leca (1954) divided the sensory part of the fifth lumbar nerve-root in 49 patients and the first sacral root in 83 patients They found a narrow band of cutaneous analgesia along the

posterior aspect of the thigh in each case, and that the first and second toes became numb after section of the fifth lumbar posterior root, and the outer two toes after section at the first sacral level This fits in extremely accurately with the usual distribution of pain in *sciatica* and *affords the first experimental* evidence of the existence of a posterior crural extension of these two dermatomes

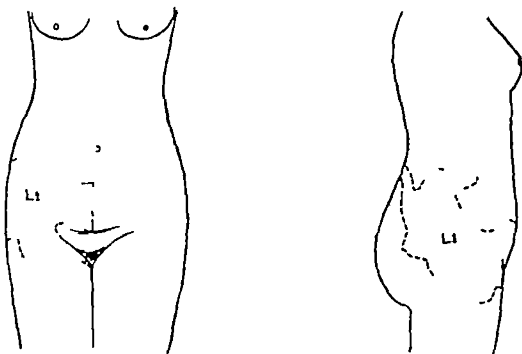


FIG 14.—1st lumbar dermatome.

Sacral 2 The back of the whole thigh, leg, sole and the plantar aspect of the toes (Fig 21)

Sacral 3 Uncertain (Probably a narrow strip following the inguinal ligament and running down the inner side of the thigh to the knee)

Sacral 4 Saddle-area, anus, perineum, scrotum and penis, labium and *vagina*, *inner uppermost thigh*.

EMBRYOLOGICAL DERIVATION

The dermatomes do no more than represent the original relationship to the trunk of the limb-buds at the earliest

stage of development of the embryo. At the end of a month's development the limb-buds appear as raised papules at each side of the neck and caudal region. During growth, these projections draw out into themselves the segments from which they start, thereby deforming at these areas the original circular shape of each segment Thus, some segments are

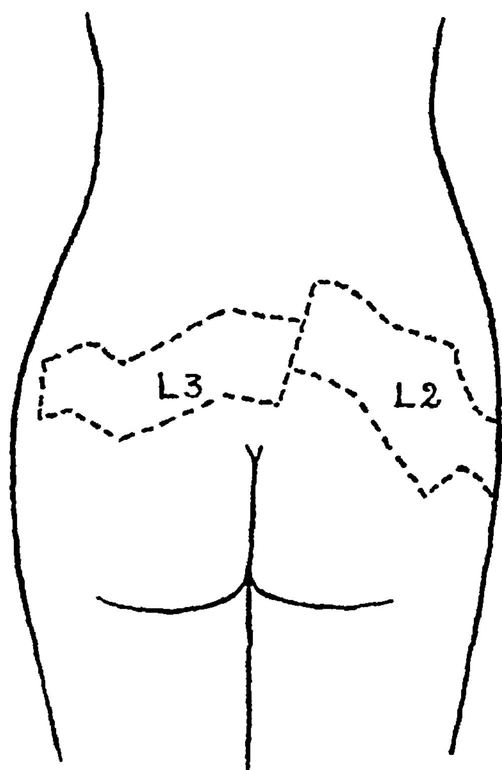


Fig 15—Posterior portion of 2nd and 3rd lumbar dermatomes

largely missing from the trunk in the lower-cervical-upper-thoracic and in the lower-lumbar-upper-sacral regions; they have gone to form the limbs. If the upper limb is held out horizontally, thumb upwards, the original position of the bud is recreated. Thus, the thumb represents the end of the elongated fifth cervical segment, the thumb and index the sixth, the long and ring fingers the seventh, the ring and little fingers the eighth cervical, and the ulnar border of the wrist the first thoracic segment.

The third to twelfth thoracic segments suffer no comparable deformation; the lower merely come to slope obliquely downwards anteriorly so as to form the abdominal wall.

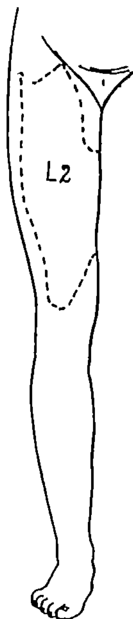


FIG. 16.—Anterior portion of 2nd lumbar dermatome.

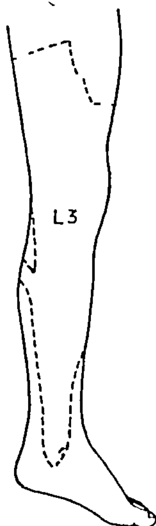


FIG. 17.—Portion of 3rd lumbar dermatome in lower limb.

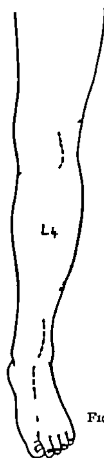


FIG. 18.—4th lumbar dermatome.

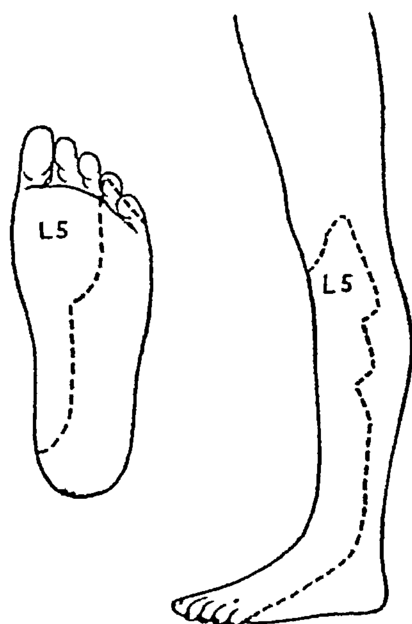


Fig 19 —5th lumbar dermatome

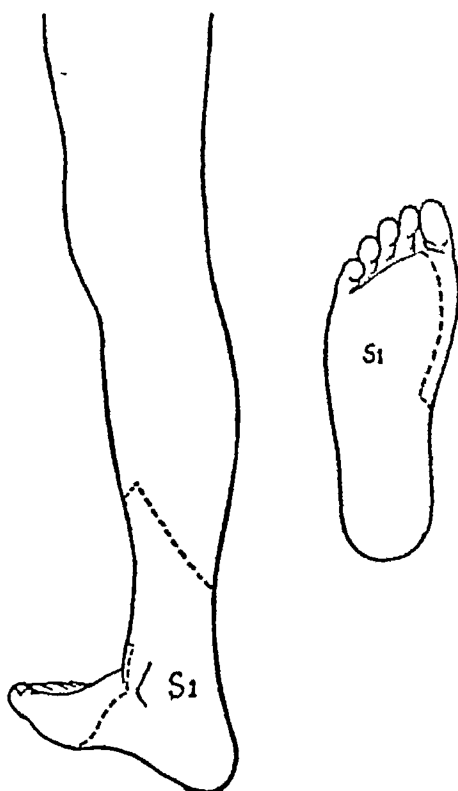


Fig. 20.—1st sacral dermatome

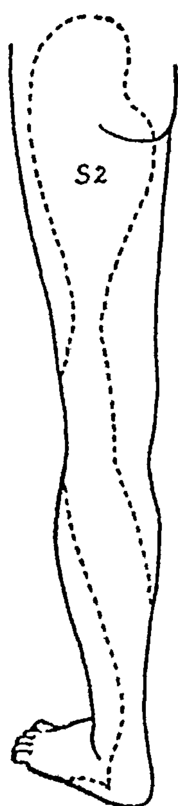


Fig. 21 —2nd sacral dermatome

The original position of the bud for the lower limb is recreated by abduction of the thigh to 90° and lateral rotation until the big toe points vertically. The second and third lumbar segments now lie uppermost, i.e. the adductor and quadriceps muscles. The lower part of the quadriceps muscle and the front of the leg form the fourth lumbar segment, which is also represented in the buttock by the gluteus medius and minimus muscles. Of course, each segment also takes part in the sacrospinalis muscle at the appropriate level. The fifth lumbar segment reaches to the hallux, forming together with the first sacral segment, the foot and calf. These two myotomes are also represented in the gluteus maximus and take a small share in the other two gluteal muscles. The hamstring and upper calf muscles are formed from the upper two sacral myotomes except for the biceps femoris muscle which is chiefly derived from the third sacral segment. The fourth sacral segment forms the perineum and anus.

DISCREPANCIES BETWEEN DERMATOMES AND MYOTOMES

There are seven areas where the skin and the structures it covers have different embryological derivations; these require special mention. They are the head, the scapular, pectoral, and intrathoracic regions, and the hand, buttock and thigh. Discrepancies also occur within the abdomen but do not appreciably concern the practitioner of orthopædic medicine.

1. *The Head.* When the embryo is about four weeks old, the projection that will form the head turns twice in the course of growth until it is folded forward on itself like an inverted J. Meanwhile the future mandibular region has appeared as an anterior fold. These two protuberances then fuse about the *gap that forms the buccal cavity*. In other words, the whole of the head and face as far as the mouth is developed from the back of the neck, and only the lower jaw region develops from the front of the neck. The head and face are formed from the upper two cervical segments.

The nerve which conducts sensory impulses from the skin of the face and scalp as far back as the vertex is, of course, the fifth cranial. There is, then, no nerve along which a pain

could run from the back of the neck to the forehead. Since such reference of pain does occur, this provides an excellent illustration that a referred pain does not run down a somatic nerve but represents an error in perception. The patient feels a pain somewhere within, or, when the strength of the stimulus is great enough, diffused all over the segment in which it arises.

2. *The Scapular Region.* The growth of the bud that is to become the upper limb draws the lower cervical and uppermost thoracic segments out into itself. The scapula and its muscles (including the latissimus dorsi muscle) are derived from the middle and lower cervical segments, yet the skin overlying, and the ribs beneath, them are formed from thoracic segments. Hence pain in the upper posterior part of the thorax has a cervical or circumscapular origin if it radiates to the shoulder and upper limb, and a spinal or paravertebral origin if it radiates to the front of the chest.

3. *The Pectoral Region* The state of affairs is the same as at the scapula. The intercostal muscles, the ribs and the overlying skin form part of the thoracic segments, whereas the pectoral muscles are developed from the lower part of the neck.

4. *The Intrathoracic Region.* The diaphragm is developed largely from the third to fifth cervical segments. The heart forms part of the upper three thoracic segments. Pain from either structure may, therefore, be felt to radiate to the shoulder and down the upper limb, since the fifth cervical segment reaches to the thumb and the first thoracic segment to the wrist. Hence pain referred from the diaphragm, heart or the pectoral muscles may have the same quality and a similar projection (*i.e.* along the upper limb). Since, moreover, all three are thoracic structures, the local pains to which they may give rise are indistinguishable to the patient. Failure to bear these facts in mind may lead to grave errors in diagnosis. Thus it should never be assumed that pains starting on the left side of the chest and running down towards the hand are necessarily of myocardial origin.

5. *The Hand.* The skin of the radial side of the hand is developed from the fifth and sixth cervical segments, whereas

the thenar and interosseous muscles form part of the eighth cervical and first thoracic myotomes

6 *The Buttock* The whole of the skin of the buttock is derived from the first lumbar dermatome, overlapping the second and third segments at a small area at the upper inner quadrant (see Fig 14) By contrast the gluteal muscles are almost wholly formed from the fourth lumbar to first sacral myotomes

7 *The Thigh* Patients found to be suffering from fourth and fifth lumbar nerve-root pressure repeatedly describe their pain as spreading to the buttock, then to the thigh Only seldom does the patient state that the pain jumps from buttock to calf omitting the thigh Yet the fourth and fifth dermatomes start at, or just above, the knee. It is thus theoretically impossible for pain to be felt in the thigh in sciatica yet that is in fact the commonest site for severe pain This phenomenon remained unexplained until Sicard and Leca's findings (1954) after posterior radicotomy at the fifth lumbar and first sacral levels They were able to demonstrate a narrow band of cutaneous analgesia running along the posterior aspect of the thigh when either posterior root was divided Hence, a hitherto unsuspected part of the dermatome has been charted, and accounts for the well known crural radiation of the pain in sciatica.

Exception to Segmental Reference

For reasons that remain obscure, the dura mater does not obey the rules of segmental reference at all. This fact has never been stated and is entirely unknown to clinicians For example patients with cervical root pressure are seen who have headache at the same time as pectoral or scapular pain Patients may have a seventh root paresis, yet the first symptom was often upper thoracic central pain, later becoming diffused over the whole of one scapular area. Thus, in the stage of first central, then lateral dural pressure, the pain is usually felt in areas derived from a segment quite other than that in due course found to contain the lesion. Once the protusion has reached the nerve root, the pain radiates in the expected way hence it is irritation of the

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dura only, not its investment of the nerve root, that sets up pain felt at the wrong level. The reverse phenomenon may be experienced during gradual manipulative reduction of a cervical intra-articular displacement; pain felt, as it should be, in the upper limb may become converted to a pain felt only, say, in the lower or outer scapular area, or be replaced by headache. Judging therefore by clinical evidence, one source of pain in the pectoral or upper posterior thoracic area is unilateral pressure on the dura mater, exerted at a mid or lower cervical level.

The same phenomenon occurs in the lumbar region. Backache caused by pressure on the dura mater at the lower two lumbar levels often radiates up to the lower thorax. Patients even state that their lumbago is accompanied by a headache that comes and goes with the lumbar symptoms. The pain of dural pressure in acute lumbago caused by a lower lumbar protrusion often radiates to one groin, and one or both iliac fossæ, thus encroaching on lower thoracic segments. Since the possibility of such segmental transgression has never been described and results in pain whose pathway is anatomically inexplicable, suspicion of renal calculus or appendicitis may easily arise. I have even known patients, when manipulative reduction at the lower lumbar spinal joints is undertaken, feel the thud occasioned by reduction to take place in the neck when my hand has clearly perceived it at the lower back.

Other structures in the neighbourhood of the dura mater do not share its independence from segmental reference of pain; hence the mere fact that the patient, if he is judged sincere, describes a reference of pain that is theoretically impossible, should at once focus the examiner's attention on the dura mater. It follows from what has been said that the site of pain, taken alone, cannot necessarily differentiate between a cervical, a thoracic or a lumbar disc-lesion setting up dural pressure. In any of these three cases, the symptoms may be largely thoracic. In the case of no other structure could such a wide field of projection of the symptoms exist.

Referred Pain as a Clue to Segmental Origin

The knowledge that pain is referred segmentally, apart from being employed clinically to estimate the limits within which

the source of a pain must lie, may also be used experimentally to demonstrate the embryological origin of the structure concerned For example, the lumbar fibres of the latissimus dorsi muscle, which never give rise to pain projected to the upper limb, must be developed separately from the superior part of the muscle, pain from which may be felt to reach the arm.

The capsule of the hip-joint provides another instance. Pain originating in this structure may be felt correctly as a local pain in the groin and buttock. As a rule reference occurs only to the front of the thigh, to any part of the knee and, occasionally to the anterior aspect of the leg almost to the ankle. It follows that the capsule of the hip-joint is developed largely from the third lumbar segment. Very rarely the capsule is wholly formed from the fourth lumbar segment, the pain radiating to the outer leg along the lateral border of the thigh

The map of the segments obtained by collating the results of clinical observation of this type agrees very closely with Foerster's work. It does not confirm the diagram in Lewis's work *Pain* (1942) which is built up from the findings he and Kellgren obtained by the injection of irritants. It would seem that by this means only the proximal areas of reference can be charted accurately

CONDITIONS FAVOURING REFERENCE OF PAIN

The erroneous perception of the site of a pain depends on four factors (1) the strength of the stimulus, (2) the position of the painful structure, (3) the depth from the surface, and (4) the nature of the structure.

(1) *The Strength of the Stimulus*

The stronger the stimulus, the less can the patient tell where it originates For example, arthritis at the shoulder starts as a pain at the shoulder If it becomes more severe, the pain spreads to the arm and forearm, possibly leaving the shoulder area altogether When the arthritis regresses, the reverse phenomenon takes place. In other words the position

of slight pains is often correctly appreciated by the patient; intense pain radiates widely.

The mechanism of this phenomenon remained obscure until recently. On general grounds it could be assumed that the error lay centrally rather than peripherally; for a larger number of sensory nerve fibres would clearly not be stimulated by an increase in the severity of a lesion unaccompanied by an increase in its extent The mechanism by which pain is referred was revealed by the experiments of Woolsey, Marshall and Bard (1941) on monkeys. Electro-encephalography showed that stimulation of a given area of skin gave rise to an electrical reaction in a fixed and minute area of cortex. Increase in the intensity of the stimulus led to a corresponding increase in the number of cortical cells affected. Such spread to adjacent cells would obviously be interpreted by the patient as an enlargement of the painful area.

The mosaic forming the sensory cortex is arranged dermatome by dermatome, and the extensive reaction resulting from a strong stimulus is confined within the limits of the piece of cortex corresponding to that dermatome. The absence of spread beyond the limit of each piece of cortex is demonstrated most clearly at the two points in the sensory cortex where the arrangement departs from the normal sequence. The region of sensorium corresponding to the fifth cranial nerve adjoins that corresponding to the eighth cervical segment, and the second cervical and first thoracic areas also lie next to each other. Cerebral spread beyond a dermatome would, in these two situations, give rise to bizarre distributions. Except in disease of the brain itself, clinical experience shows that this type of reference of symptoms (*e.g.* from the face to the ulnar side of the hand) does not in fact take place. The fact that the diffusion occurs at the cells of the sensory cortex also explains why amputation distal to the lesion does not prevent the radiation of pain to the absent part. The phenomenon that electro-encephalography fails to explain is the replacement of an original pain by referred pain, symptoms being no longer experienced at the site of the lesion but distally only.

(2) The Position of the Painful Structure

Pain will be referred a long way only where elongated segments exist, i.e in the limbs. The longest segments are the fourth and fifth lumbar and the first and second sacral which stretch from the lower back to the foot.

As a rule, pain is referred only distally, and it is therefore from the proximal ends of the longer segments that diffuse pains usually arise. The structures about the knee and elbow stand almost alone in setting up pain felt to radiate equally in both directions, but the patient seldom fails to realize the source of his symptoms Pain originating about the wrist or tarsus may also set up an ache in the forearm or leg but never enough to deceive the patient as to its source. Thus a diffuse pain may be expected to spring from a structure placed towards the upper end of the painful segment, but by no means necessarily within the area outlined by the patient.

Conversely, the further the lesion lies from the trunk, the more accurate are the patient s sensations. Thus, although there is no theoretical reason why a pain in the foot should not be felt to travel to the buttock, just as a pain arising in the buttock is felt to reach the foot, in fact this does not occur

(3) The Depth from the Surface

The more superficially a soft structure lies, the more localizing ability it possesses (Kellgren, 1938) One of the most important functions of the skin is to localize tactile stimuli, and pains are therefore not referred from its surface even so the fingers can localize to within a millimetre, whereas the skin of the back can only do so to within two centimetres It is no part of the ordinary function of deep structures like muscle to localize stimuli accurately Up to a point, the more deeply a soft structure lies, the greater is its capacity for giving rise to diffuse pains

Lewis (1942) put forward the same hypothesis He says

'We assume that a unit area of skin must transmit, by its special path, sensory impulses to the sensorium which is able to recognize this unit as the source of the message.

Tissues supplied by deep pain nerves may be regarded as

endowed with a similar but simpler form of mechanism, the tissues being represented more in bulk and collectively. The coarsest form of such representation would be that in which tissues in a given segment were represented in such a way that no fine distinctions would be possible in localization."

While the concept of referred pain as no more than an error in perception on the part of the cerebrum is clear enough, the fact that pain arising from the proximal part of a segment is usually felt over a much larger area than when its source lies distally does give rise to difficulty. For example, the pain of sacro-iliac arthritis may radiate to the calf, but calf pains are very seldom projected as far as the buttock. Thus, the deep tissues of the calf must be connected with the sensorium separately from the buttock muscles. Further research is required to elucidate the paradox formed by these two conflicting observations—namely, that the buttock and calf possess both common and separate representation in the sensory cortex.

(4) *The Nature of the Structure*

Pressure applied to the spinal cord is apt to produce pins and needles felt in the lower limbs only, often the soles of both feet. The reference is usually bilateral and does not follow any dermatome. The most deceptive and distant reference in my experience was when manipulative reduction carried out at the neck abolished paræsthesiæ felt only at one big toe. There was no other symptom.

Pain arising in a nerve-trunk is felt in the area of skin supplied by that nerve wherever the stimulus is applied. Thus, it is common experience that no matter what part of the sciatic nerve-trunk is irritated by pressure, it is in the foot that the paræsthesiæ are felt. The reason is that a stimulus applied directly to the trunk of a sensory nerve sets up an impulse travelling proximally—an impulse which the sensory cortex interprets as originating from the area of tissue supplied by that fibre. No pain is appreciated from the actual site of the pressure. Th[illegible] trun[illegible] pain more deceptively than any oth[illegible] ; for the perineurium is not conc[illegible] might well have been suppose[illegible] uld be

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Pain is apt to be referred from joint-capsule to a greater distance than from structures such as ligament, muscle and bursa Thus the sacro-iliac, hip and shoulder joints often refer pain travelling along the whole limb whereas the muscles about these joints more often set up pain felt in the vicinity only Bone and periosteum, though the most deeply situated structures of a limb, set up pain that hardly radiates at all Thus fractures and uncomplicated bony abnormalities due to infection or new growth give rise to pain felt close to their site. There is no obvious reason for this discrepancy between hard and soft structures.

DIAGNOSIS OF REFERRED PAIN

Referred pain should always be suspected when a patient complains of a deep burning or aching running along a limb of ' neuritis," or indeed of any deep pain of large extent and indefinite boundaries. Furthermore, if the painful area presents no physical signs of disorder and there is no disturbance of function of the painful part, the probability that the pain is referred is very high.

Of the structures from which pain is referred, the following concern the orthopædic physician joint capsule, tendon, muscle, ligament and bursa, in order of descending importance. To these must be added dura mater and nerve-sheath for it is the orthopædic physician who is commonly called upon to deal with pressure on dura mater, nerve-root or nerve-trunk, even though the diagnosis is often made by the neurologist.

There is a great diversity of lesions that can give rise to referred pain, and it is essential to consider each case as an isolated problem on the lines described in Chapter VI Though these pains are often called neuritis by the patient, they are not due to pain arising in, travelling along, or even dependent on the integrity of, the nerve-paths distal to the site of the lesion. They pass upwards from the site of the stimulus by the ordinary sensory paths, but they do not run *down* any structure their site is merely erroneously localized by the patient s brain and can indeed be felt in an absent limb, or one deprived of its nerve supply

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no more diffuse than those from other fibrous structures in the same neighbourhood

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PRACTICAL CONSIDERATIONS

Referred pain can be relieved only by treatment applied to its source. Patients often unwittingly draw attention away from the right spot by insisting that they know from their feelings exactly where the lesion lies, and by rubbing themselves on what they maintain is the tender place. Unless the patient points to a place within the group of structures involved in the painful movement his views must be ignored; and even when he points to a place within this group his indications still require confirmation.

It should be clearly understood that the treatment is exactly the same whether a lesion gives rise to referred pain or to local pain only. The diagnostic difficulties are sometimes increased in the former case; but once the right structure has been singled out, it is treated on standard lines. Moreover, since referred pain does not arise from superficial structures, superficial treatment cannot affect its source. Whatever therapeutic measure is employed, it must have a penetrating effect.

It would be a great step forward in the practice of physiotherapy if medical men, before handing over cases of diffuse pain *for treatment, made a point of giving clear directions* as to the site to which treatment should be applied. Physiotherapists themselves have some responsibility in the matter, and it is their duty, whenever possible, to secure a precise diagnosis before setting to work. Obviously if this endeavour fails, they must of necessity do the best they can with routine measures of diffuse effect. They will, I hope, remember that accurate treatment should never be attempted unless an exact diagnosis has been arrived at first.

CHAPTER IV

NEURITIS AND PRESSURE ON NERVES

THE layman often uses the word "neuritis" to designate any deeply situated diffuse pain. Many probably most, patients making this complaint are suffering from referred pain clearly demonstrable as taking origin from a deeply placed somatic tissue. Others, complaining of "neuritis," are found to have some disease of the nervous system, often due to pressure exerted on a nerve-root or nerve-trunk. The medical profession, probably as a result of long-established usage, has to some extent adopted the layman's loose application of "neuritis" as a synonym for pain, thus depriving the word of its precise pathological meaning. This custom should be discontinued for the different sources of the pains once grouped together under the one term are distinguishable clinically, and each requires separate methods of treatment.

Pressure on a nerve from without occupies the territory where the neurologist and the practitioner of orthopædic medicine meet. The nerves may conduct normally, hence involvement of the nervous system appears excluded. Examination of the somatic structures appears equally to exclude any lesion affecting a moving part of the body. The patient may, therefore, fall between two stools, neither type of examination revealing the existence of a lesion. In fact, the source of the pain lies at the nerve-sheath, the examination of which requires special methods and is thus apt to be neglected (Cyriax, 1942).

PINS AND NEEDLES

This feeling is a most interesting phenomenon, for it appears to provide the only example of a pathognomonic sensation. Lesions of visceral, skeletal or muscular provenance all give rise to identical pains: whatever the tissue affected, symptoms indistinguishable by the patient result. The pains may behave differently (e.g. in colic) but they are

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identical in quality. Pins and needles, by contrast, arise only from lesions of the nervous, especially the peripheral nervous, system.

Tingling and numbness, but not true pins and needles, occur in vascular, as well as nervous, disorders, but in such cases the hand or foot changes colour. Generalized pins and needles occur in subacute combined degeneration of the cord and in peripheral neuritis (*e.g.* as the result of diabetes); therefore it is well to establish that the paræsthesiæ are confined to one part of the body and are not accompanied by alteration in colour or temperature of the affected area, before concluding that pressure on a nerve is the cause. However, it must be remembered that paræsthesiæ in both hands and both feet may result from a cervical disc-lesion protruding centrally against the spinal cord.

Pins and needles are felt only in the distal part of the cutaneous area supplied by a peripheral nerve, no matter at what point in its course the constriction is placed They are temporarily increased by any movement of the paræsthetic part or by stimulating the affected area of skin; hence the fact that they are produced or increased by a local movement has no diagnostic significance. On the other hand, if they are affected by a distant movement, this constitutes the important localizing finding. Faint pins and needles, amounting rather to a mixture of tingling and numbness, appear when a nerve-trunk is compressed; painful pins and needles occur some time after the pressure on a nerve has been released, the interval bearing a close relationship to the duration of the original pressure. Thus, after five minutes' pressure, the paræsthesiæ will appear after perhaps thirty seconds; after release from twelve hours' compression they may not be felt for two to three hours. Hence pins and needles, especially when they come on with real force, should be regarded as a *release phenomenon*, in conditions affecting a nerve *trunk*. When a nerve-*root* is squeezed, however, constant pins and needles may be felt as long as the compression continues. This is common at lower cervical levels, less common at lower lumbar levels and appears not to occur at the thoracic nerve-roots.

When a nerve is compressed the symptoms are perceived distally only, *with one exception*. When the dural investment

of a nerve-root is compressed at its entry into an intervertebral foramen, local pain in the trunk is the first symptom. Since this fact has not been appreciated many have been misled and the symptom is universally mistaken for "fibrositis" However, clinical examination shows at once that the muscles, though they are tender at the place where the pain is felt, are none of them painful when their function is tested. This appearance of pain in the trunk only when the root is compressed provides a most welcome antithesis For example, cervical *nerve root* compression results in pain felt first in the trunk, later in the limb, finally in paræsthesiæ felt in the hand. By contrast, pressure on a *trunk* of the brachial plexus, or on a peripheral nerve in the upper limb, results in pins and needles felt in the hand accompanied, much later on perhaps, by minor aching in the upper limb, sometimes as far up as the shoulder Nothing at all is felt in the vicinity of the lesion. The emphasis and order of appearance of symptoms is thus reversed in the two cases

Constant pressure on a nerve-trunk causes a painless lower motor neurone lesion, there are no paræsthesiæ

When pins and needles are felt in the hand, it is essential to discover in which digits they are felt. This requires close questioning for patients' first statement is often modified if the paræsthesiæ can be provoked and they pay real attention to their exact site. If the inner one and a half or the outer three and a half digits are affected, the lesion probably, but not necessarily, lies distal to the shoulder By contrast, if the site of the pins and needles fails to conform to the cutaneous distribution of a peripheral nerve, the lesion must lie above the point where the brachial plexus becomes differentiated into its final branches, *i.e* at the thoracic outlet, or at the emergence of a nerve-root from the intervertebral foramen.

Pins and needles felt in all four limbs, or in the upper or in the lower limbs only, characterize a minor degree of pressure on the spinal cord in the neck and upper thorax. When the cord is compressed at its lower thoracic extent, the paræsthesiæ are felt solely in the lower limbs, often only in the feet. Neck flexion is usually the only way to bring the pins and needles on. These sensations may also be provoked during cisternal puncture. If by chance, the

needle touches the cuneate or gracile tracts, pins and needles appear suddenly in the limbs and trunk. In central cervical disc-lesions pins and needles may be felt in the lower limbs, their extra-segmental distribution often providing the diagnostic clue, *e g.* down the front of the legs to the soles of the feet or affecting face, hand and foot all on the same side.

At cervical laminectomy Frykholm (1951) showed that stimulation of the anterior division of the nerve-root gave rise to deep pain associated with muscle tenderness whereas stimulation of the posterior division brought on a more peripheral pain associated with paræsthesiæ. Since disc-lesions impinge first on one aspect of a nerve-root rather than all round it—depending whether the pulpy material passes above or below or through the annulus—it follows that the reason why root-pressure sometimes causes pain with, sometimes without, pins and needles depends on the origin, anterior or posterior, of the fibres receiving the main impact.

NOMENCLATURE

NEURITIS

Conduction along a nerve can suffer in two ways: from primary degeneration of the parenchyma or from pressure exerted on the nerve from without. The term "neuritis" should be reserved for cases in which neurological examination discloses signs of diminished conduction along a peripheral nerve as the result of lesions confined to the parenchyma. Neuritis is an unsuitable term when conduction suffers secondarily in disorders whose primary impact is on the nerve-sheath. This nomenclature has the immediate practical advantage of focusing attention on the structure at fault. In the past, loosely-made diagnoses of "neuritis" have given rise to much confusion of thought on the nature, and therefore on the treatment, of the different types of disorder included within the category. "Neuritis" unaccompanied by an adjective indicating what type of neuritis is present is always an incomplete diagnosis.

The vague term "brachial neuritis" or "neuralgia" is an excellent example of the difficulties that can be caused by a mere name. This diagnosis naturally suggests disease of the

peripheral nerves supplying the upper limb, whereas it is sometimes not used when a nerve-lesion is present and often employed when neuritis is absent. True bilateral brachial neuritis occurs, of course, as part of a polyneuritis when this is so, it is more usual to refer to the cause, generally diabetes or poisoning by diphtheria toxin, alcohol, a heavy metal or an industrial solvent. A scapulo-brachial neuritis of unknown origin also occurs it is probably due to virus infection akin to anterior poliomyelitis and herpes zoster The signs of a brachial neuritis may appear as the result of a traction palsy, or of protrusion of part of a cervical inter vertebral disc, or they may be set up by pressure on the brachial plexus or on individual nerves. Such cases are properly described as cervical rib ulnar neuritis and the like. Hence it is high time that ' brachial neuritis "—a blunder buss label devoid of localizing significance—was replaced by a number of definite terms.

In itself wide radiation of pain cannot be regarded as justifying a diagnosis of interference with a nerve. Equally diffuse symptoms may result, not only from pressure confined to a nerve-sheath, but from lesions of deeply placed somatic tissues, especially joint-capsules. In severe arthritis at the hip or shoulder, for example, pain may be projected along the whole length of the limb but there is no involvement of the nervous system. Under the appropriate name, the pathology is obvious and the considerations underlying the choice of methods of treatment can be precisely formulated

In neuritis the mobility of the nerve sheath remains un affected, hence stretching the nerve never causes pain in un complicated neuritis

PRESSURE ON A NERVE ROOT

This sets up, not the lancinating stab of neuralgia, but a continuous burning ache closely resembling that caused by severe involvement of any other fibrous structure. When (as is usual) only one nerve-root is affected, segmental refer ence of great accuracy is obtained Other soft structures, since they are often composed of two or more segments, give rise to pains felt more generally about the distal part of the limb In contrast to neuritis, lesions affecting the sheath of

a nerve are often characterized by an increase in symptoms when the nerve-trunk or nerve-root is squeezed or stretched. Moreover, when the sheath of a nerve is affected primarily, local anæsthesia induced there destroys the pain for the time being. In neuritis the sheath is not involved, the lesion being confined to the inner conducting core of the nerve; local anæsthesia is without effect.

Both in cases of neuritis and external pressure, movement of the painful member distal to the lesion leaves the symptoms unaltered or may even relieve them slightly, in affections of joints or muscles, use naturally increases pain.

NEURALGIA

This term is used for pains arising, apparently spontaneously, within the cutaneous area supplied by a sensory nerve. Paroxysms of pain occur at intervals with periods of complete freedom in between. The short sharp stab of neuralgia is quite different from the continuous ache, for example, of subacute arthritis or of pressure on a nerve-root, and should not be confused with the sharp twinge characterizing subluxation of a loose body within a joint. No matter how long the neuralgia lasts, conduction along the nerve never becomes impaired. The fifth cranial is the only nerve commonly affected. The lightning pains of tabes dorsalis also represent a type of neuralgia.

Post-herpetic neuralgia may arise after infection of a posterior spinal ganglion with herpes zoster virus. This is a continuous ache, punctuated by stabbing pains, felt in the area where the vesicles appeared. Occasionally conduction along the relevant part of the nervous system is temporarily or permanently impaired. Only the history distinguishes post-herpetic neuralgia, the duration of which increases with the age of the patient. In the elderly the pain may go on for a year or even indefinitely. When segmental muscular palsy complicates post-herpetic neuralgia, it is clear that the inflammatory process, instead of remaining confined to the posterior root ganglion, has spread to some of the anterior horn cells of the same segment. No method of physical treatment known to me has any effect, but the antihistamine substances are said to bring relief.

Painful neuromata in amputation stumps give rise to both the shooting pains of neuralgia and the burning ache characterizing affections of a nerve-sheath they may be felt in the stump or in the absent limb

'Brachial neuralgia" means, so far as I can make out, no more than pain in the upper limb The term has no diagnostic meaning and should be abandoned.

CAUSALGIA

The use of this term should be confined to cases in which the following criteria are satisfied (*a*) a history of injury involving a nerve, (*b*) long standing constant burning pain involving the distal part of a limb, aggravated by changes in temperature or attempted movement (*c*) trophic change distally, coming on some time after the injury

Lewis regards the pain as arising from the peripheral release of a chemical substance which excites the sensory nerve endings. More recently, vasomotor studies have revealed a persistent increase in blood flow in the whole limb and a condition best described as capillary hypertension Indeed the capillaries can be seen on microscopy to be dilated and pulsating The pain is severe, even agonizing, and though often requested by the patient, amputation brings no relief It is difficult to reconcile this fact with either of these theories. Neither dividing the spinal cord vertically into two halves, thereby severing the pain carrying fibres of the spino-thalamic tract, nor any other operation on the somatic nervous system appears to have any effect. However cure often follows removal of the appropriate autonomic ganglion If the pain disappears for the duration of anæsthesia after blocking of the stellate ganglion or after an injection of tetraethylammonium bromide, removal of this ganglion is indicated. Slessor (1947) in a review of twenty two cases confirms the beneficial effect of ganglionectomy and states that relief had lasted for over three years As in other forms of intractable pain, leucotomy offers a final resort.

M. A. Falconer (1953) has put forward a more acceptable theory to explain pain in a phantom limb He adduces evidence that in some cases the cells of the secondary neurones in the spinal cord are themselves responsible for the pain.

He has found the symptoms relievable by antero-lateral chordotomy, without impairing awareness of the phantom itself. In his view, the cells, deprived of the continuous stimuli that normally reach them, discharge either spontaneously or as a reaction to aberrant impulses, thus causing causalgia. This theory serves to explain how percussion of neuromata affords relief. The hammering restores the lacking afferent stimuli to an intensity high enough to abolish the pain of excessive quiescence.

REFERRED PAIN

The pseudo-neuritic pain referred from many deep-seated lesions placed at the proximal ends of long segments has been dealt with in Chapter III. It is a common cause of the pains called "neuritis" by the patient.

PERIPHERAL NEURITIS

Sufferers from a localized neuritis seldom use this word to describe their symptoms but are more apt to refer to some weakness, and to numbness or paræsthesiæ at an area of skin. Pain, though rarely absent except when a purely motor nerve such as the facial is involved, is usually less prominent a symptom than loss of muscle power and of cutaneous sensibility.

TOXIC NEURITIS

Toxic neuritis does not come within the scope of this book. It is a serious disease often accompanied by myocardial degeneration; physiotherapy can do nothing to relieve it. Passive and active movements ensure that the joints retain their mobility, and that disuse does not needlessly accentuate the muscular wasting caused by the neuritis. But the idea that physiotherapy can affect neuritis as such appears to spring from the very confusion of thought that has already been criticized. Since the orthopædic physician can regularly relieve the sort of "neuritis" that is caused by pressure on a nerve or by pain referred from a somatic structure, analogy

has suggested that he can also deal with other types Here again the importance of nomenclature is obvious

Minor cases of this disorder, if fever at the onset is absent or unnoticed, are often regarded as "rheumatic." The patient develops a generalized aching more severe in the limbs, and retires to bed on account of weakness in the legs rather than as a result of pain Examination at this time shows weakness and wasting of the muscles controlling the shoulder and those at the buttocks and thighs

After many weeks in bed, he gradually begins to get about again. He may be seen in a physiotherapy department two or three months later By this time, if elderly, he will have developed limitation of movement at both shoulder joints as the result of not having been able to move his arms It is then easy to regard the muscular wasting as secondary to the capsular contracture at the shoulders, and the disproportionate muscle weakness, if noted at all, is regarded unjustly as a psychogenic overlay

RADIUM NEURITIS

This is usually the result of excessive radiation reaching the brachial plexus during the treatment of carcinoma of the breast and causes severe pain lasting many months, even years. Sometimes a complete and lasting palsy of the whole upper limb results.

INFECTIOUS NEURITIS

This is a puzzling disease, lying halfway between herpes zoster and anterior poliomyelitis, presumably caused by a virus. It is distinguishable from the former by the absence of vesicles and from the latter by (1) the absence of fever or any constitutional symptoms, (2) the absence of extension of the paralysis to muscles outside the thoraco-brachial area, and (3) by the presence, as a rule, of pain. So far as my experience goes, infectious neuritis attacks only the scapulo-thoracic muscles and the proximal part of the upper limb

The first symptom is unprovoked unilateral pain felt continuously in the upper thorax day and night, unaffected by rest or exertion. After a week or so, the pain may spread to

the arm; by the end of two or three weeks the pain has gone. At no time are pins and needles felt. After some days the patient notices weakness of one arm. Examination shows the serratus anterior or the two spinatus muscles, or both, to be very weak and wasted. Other muscles are involved only rarely; if so, all the muscles developed from the fifth and sixth myotomes are usually affected. If the long thoracic nerve is affected alone, there may be a fortnight's pain, but sometimes no discomfort at all; paralysis of the serratus anterior muscle ensues. Paralysis of the trapezius following a spinal accessory neuritis is a rarity; it comes on painlessly. In cases contracted in England spontaneous recovery of the affected muscles in the course of two to six months is the rule, but when contracted in the Middle East eventual spontaneous recovery of muscle power is much less certain (Wyburn-Mason, 1941; Spillane, 1943).

No treatment is effective or required, except that a full range of movement at the shoulder may need to be maintained.

TRAUMATIC PALSY

Trauma, whether by direct violence or by stretching, may, without severence, cause partial or complete loss of conduction along a nerve. Such cases require instruction, not necessarily treatment, from a physiotherapist If the nerve is divided, similar measures are called for pending and after operative suture of the nerve. On account of the long period of disablement, the maintenance of mobility and morale by suitable therapeutic occupations should always be considered.

In minor degrees of physiological interruption muscular wasting may not be extreme and some contraction on voluntary effort and on faradic stimulation is detectable, even though the power is insufficient to move the limb. Some return of voluntary movement may then be expected at the end of one or two months, and full recovery in three to four months. On the other hand, injuries resulting in severe pressure or traction on the nerve may give rise to a complete palsy with full wasting of the muscles concerned. The

faradic response is lost and anæsthesia of the corresponding cutaneous area appears. Six to eight months then elapse before power and sensation begin to return recovery is the rule and becomes full at the end of another equal period

The most obvious feature is muscular weakness In mild cases and in those in which the paralysis is masked by con traction of a muscle supplied by another nerve, trial of the resisted movements shows that they lack power but do not increase the pain. In severe muscular and tendinous lesions the resisted movements may hurt so much that the patient is inhibited from performing them, this is not neurological weakness. Other signs of nervous disease should be sought they may however be absent, particularly in traction or compression palsy of one of the cervical nerve-roots the muscular weakness proving an isolated finding In difficult cases, electromyography may be employed to clear up a doubtful point.

TREATMENT OF TRAUMATIC PALSY

There is no evidence that any method of treatment is necessary for or hastens, recovery of the nerve in cases of physiological interruption.

Simple treatment is required for (*a*) the paralysed muscles, (*b*) the joints they serve.

(*a*) *The Paralysed Muscles*

These may require rest in the position of relaxation. Thus in a radial nerve palsy a cock up splint should be worn until the power of extension of the hand returns, but the fingers must on no account be immobilized For a peroneal palsy a toe-raising spring is needed. No treatment is required for paralysis of the spinatus or serratus anterior muscles The fibres of the deltoid muscle are not over stretched when the arm hangs by the side this occurs only on full adduction of the arm. Theoretically, splintage of the arm in abduc tion is therefore not essential in axillary nerve palsy, and in practice patients treated without it have recovered com pletely Moreover they have been saved much inconveni ence and some have continued at light work. This would

naturally have been out of the question had an abduction splint been worn. Though it is not impossible that massage, especially kneading, to the paralysed soft tissues of the limb may help to maintain circulation and nutrition, it is certainly not essential.

Contracture of muscle due to immobilization or ischæmia may require continuous traction or pressure splintage. Any increase in the range of movement should be maintained by repeated passive and, if possible, active movements.

Galvanism had been found ineffective during the first world war but was shown to be of real value by Guttmann in 1942. He demonstrated by animal experiments that wasting and fibrosis in denervated muscles could be largely prevented as long as the galvanism was begun early enough. Though the initial atrophy occurring during the first few weeks after denervation could not be obviated, the individual fibres of treated muscles retained a good size and interstitial fibrosis was much reduced. In such cases, when the nerve regenerated, the recovery of muscular function was optimal. By contrast, in the absence of galvanic treatment, the muscle fibres underwent atrophy, fibrosis advanced much further and restoration of muscle power, after the recovery of the nerve, was often bad. Jackson (1945) repeated these experiments on patients with palsies affecting the muscles of the hand. Ninety stimuli, at the rate of one every two seconds, with a minute's interval between each group of thirty stimulations, were administered daily, and the effect on the volume of the hand was compared with that of untreated controls.

These experiments showed that loss of volume in untreated muscles went on for four hundred days, whereas treatment prevented any further atrophy after that inevitably occurring during the first hundred days. Proof thus exists that galvanic treatment serves to maintain volume and mobility in the muscles of the hand, all of which lie superficially enough to be easily reached by the current. Hence, treatment should be begun as soon as possible, and continued daily. A practical method of inducing contraction of large muscles, such as those of the buttock and thigh, by galvanism without setting up too much pain was evolved by Kosman, Osbourne and Ivy (1947). They ascertained that a 25-cycle alternating current produced strong contraction of even deeply-placed

muscles with a minimum of discomfort to the patient. Experiments on rats showed that (1) atrophy following denervation was retarded as effectively by thirty seconds' as by fifteen minutes' stimulation, and (2) that three periods of treatment a day achieved the optimum result, being better than once or twice, and not surpassed by six times daily

(b) *The Affected Joints*

These must retain their full range of passive movement. To this end the patient is taught what the full range of movement at these joints is, and how to use gravity, a pulley or his other limb to put each joint through this range every day Often, treatment by a physiotherapist is essential, at any rate at first for example in recent cases of hemiplegia, on account of the patient's confused state of mind Splints should be worn to prevent deformity, *e g* a foot piece to avoid fixed equinus at the ankle, and removed before the movements are performed Occupational therapy is usually called for

Passive movements, whether carried out by the patient or the physiotherapist, are of particular importance when the shoulder or finger joints are affected Unless full movements are practised daily, these joints are particularly apt to have become stiff by the time that the power to move them has returned. Even today, a stiff shoulder in a hemiplegic patient is a commonplace. In this connexion the dangers of prescribing a sling for patients with cervical disc-lesions giving rise to pain in the upper limb should be borne in mind Capsular contracture at the shoulder may quickly supervene and gradually replace the symptoms due to the root pressure merely because daily movements at the shoulder were not carried out.

PRESSURE ON A NERVE

One of the most difficult tasks of the orthopædic physician is the differentiation of the diffuse pains set up by affections of a nerve-sheath from the equally diffuse pains set up by other soft tissue lesions. In neuritis the presence of signs

of a lower motor neurone lesion provides the diagnosis. When the external surface of a nerve is pressed on, however, none of the classical signs of neurological disease are detectable unless conduction becomes impaired. Since the prognosis and treatment are wholly different, every effort must be made to detect these cases Patients with pressure on a nerve or nerve-root do not complain without cause, for it can be a most disabling condition. The frequent slightness of physical signs therefore should not lead to the disorder being taken lightly, still less being dismissed as psychogenic.

THEORETICAL CONSIDERATIONS

There is evidence that the pain may originate from pressure on a nerve and yet conduction along it remain unimpaired (Cyriax, 1942). In such cases, the following criteria are satisfied:

1. No pain can be elicited from the muscles, joints, etc., comprising the same segments as the painful part.
2. Conduction along the nervous system is normal.
3. The pain is referred to a region obviously corresponding to the area of cutaneous supply of one nerve-root or of one peripheral nerve.

The conclusion can therefore be drawn that the pain arises in a nerve, but not in its conducting elements. In other words, it is the sheath of the nerve that is affected primarily. *This fact throws doubt on the generally accepted view that, for the examination of the peripheral nervous system, estimation of conduction along it suffices.*

Since the affected structure is a fibrous sheath, the quality of the local pain resembles that of severe affections of muscles and joints. Distally, however, the pain often differs from that of other lesions. At the fingers and foot, for example, not only may the pain occupy the known area of distribution of a nerve-root or of a cutaneous nerve, but the symptoms may include pins and needles and sensations of numbness. Examination usually shows that in fact sensation is retained in the area of skin subjectively felt to be numb. The pain is continuous, usually unaffected by movement or rest of the painful part, and is often worse at night. Heat usually makes

the pain worse and the patient may prefer to leave his limb outside the bedclothes or get up at night to walk about the room Referred tenderness of the deeper tissues at the proximal part of the painful area is a prominent and highly misleading sign. The pain may be such that the patient firmly but mistakenly believes he cannot move the affected limb

Secondary parenchymatous change, due to pressure from without, may develop in due course. When these neurological signs appear the label neuritis might seem warranted, but leads in fact to an error in emphasis, focusing attention upon the secondary rather than the primary organic process Clearly the treatment of pressure on the surface of a nerve with secondary involvement of the conducting fibres is the same as that of an uncomplicated sheath lesion By contrast primary neuritis is in no way improved by treatment of the unaffected nerve-sheath

Rheumatoid Perineuritis The careful pathological studies of Freund, Steiner, Leichentritt and Price (1942) have shown that long-standing rheumatoid arthritis is often complicated by sharply-defined inflammatory nodules in the perineurium These authors suggest that the paræsthesiæ and trophic cutaneous changes occurring in chronic cases are due to irritation of the conducting fibres of the nerve by such nodules, since microscopy revealed no abnormality of the parenchyma of the nerve. Gibson, Kersley and Desmarais (1946) have shown that nodular polymyositis also occurs in advanced rheumatoid arthritis. The nodules in muscle and nerve-sheath are absent in spondylitis deformans

SIGNS OF PRESSURE ON A NERVE

The facts set out above show that the signs fall into five groups, but are seldom all present in any one case. Occasionally no physical signs at all can be detected, the diagnosis being established on the history, the patient's sincerity, the manner of onset and subsequent migration of the symptoms, the quality of the pain and the absence of signs of any other disorder or of psychogenic pain.

It is noticeable that in almost every case nerve-sheaths

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scalenus anterior muscle in cases of cervical rib. The rib can then sink away from the nerve-trunks.

3. Alteration in the course of the nerve If progress towards neuritis becomes evident, operative anterior transposition of the ulnar nerve at the elbow is indicated.

4. Enlargement of the foramen by which a nerve pierces a fascia. This applies especially to meralgia paræsthetica where incision of the foramen of exit of the lateral cutaneous nerve of the thigh affords relief.

5. Division of the ligament confining the nerve This applies particularly to division of the transverse carpal ligament in median nerve pressure.

6. Removal of the nerve. This may be required at the sole of the foot.

PINS AND NEEDLES

Summary. The situation of the paræsthetiæ has great diagnostic value Four types exist.

1. *Local Pressure.* The paræsthesiæ occupy the cutaneous distribution of one small peripheral nerve Numbness is more marked than pins and needles and a small patch of anæsthesia is often found.

2. *Pressure on Nerve-Trunk.* The paræsthesiæ occupy the cutaneous distribution of one large nerve. They are a release phenomenon, coming on strongly after the pressure ceases. Cutaneous analgesia rather than anæsthesia is to be expected.

3. *Pressure on Nerve-Root.* The paræsthesiæ occupy the distal part of one dermatome and are a pressure phenomenon, continuing as long as the compression lasts. Pain felt throughout the dermatome is usually experienced as well. The affected area may feel numb, but actual analgesia is often absent.

4. *Pressure on Spinal Cord.* The paræsthesiæ are often bilateral and occupy areas of skin extending to several dermatomes; i.e. they are felt extra-segmentally. They are a compression phenomenon, ceasing at once when the pressure is relieved. There is no pain or analgesia in the affected regions.

CHAPTER V

NON-SPECIFIC ARTHRITIS

THERE are two main types of non-specific arthritis osteo-arthritis and the infective arthritides In each case the incidence of the disease is primarily on the joints, whose condition is not secondary to known disease elsewhere. Other joint affections comprise gout, rheumatic fever, serum sickness, alcaptonuria, psoriasis, pulmonary osteo-arthropathy, scleroderma, dermatomyositis, neurogenic arthropathy, Reiter's disease, gonorrhoeal arthritis, septic, typhoid and dysenteric arthritis, palindromic rheumatism, and the arthritis that follows a number of virus diseases such as anterior poliomyelitis or German measles

Osteo-arthritis stands entirely apart from the infective arthritides, which comprise the entities known as rheumatoid arthritis, infective arthritis and spondylitis deformans. There is no connexion whatever between these three disorders and osteo-arthritis, apart from the facts that a joint is affected in each case and that difficulty is sometimes experienced in making a differential diagnosis In osteo-arthritis the primary incidence is on cartilage, in infective arthritis, on the capsule of the joint.

The sign of arthritis is the same at every joint—limitation of movement in every direction The cause of this sign is capsular contracture, which muscular spasm then prevents from being stretched Capsular contracture takes place in a characteristic way, giving rise to a pattern of limited movement (see Chapter VI) varying from joint to joint. "Diffuse capsulitis" provides a useful synonym for arthritis and is well adapted to describe those cases in which no irreversible structural changes have occured and full recovery is possible In osteo-arthritis a slow and irreparable degeneration of the joint takes place. The lesion first affects cartilage and is usually well advanced before symptoms are noticed

Rheumatoid and infective arthritis form a group in which an active lesion exists that may progress to fibrous ankylosis, to full recovery or to a subacute phase of alternate periods of

rheumatologists. It is true that joints at which osteophytes are present are apt to develop sudden accesses of pain and limited movement. This cannot result from an acute exacerbation of the osteo-arthritis, for this is a degenerative process, not an inflammation at all Clinical examination during such an attack shows internal derangement to be present and successful manipulative reduction immediately stops the "episode" Since the subluxated loose body is usually cartilaginous all that the radiograph shows is the osteophytes and the erosion of cartilage—hence the confusion. The elbow, knee and spinal joints are those at which displacement of a small loose body is most apt to occur.

There are three sites at which osteo-arthritis appears as a degenerative phenomenon unconnected with the ætiological factors set out above. They are

1. *The Fingers.* All the fingers of both hands come to be affected. The distal joints become involved first; in due course the proximal interphalangeal joints also. The metacarpo-phalangeal joints are omitted; the next site of spread is the trapezio-first-metacarpal joint. This symmetrical and steady evolution from Heberdern's nodes, leading to multiple osteo-arthritis at all the interphalangeal joints, suggests a hereditary predisposition rather than the action over many years of mechanical factors This view is borne out by the fact that the disorder is much commoner in elderly women than in elderly men.

2. *The Tarsus* Osteophyte formation at the cuneo-first-metatarsal joint usually comes on rapidly in the course of a few weeks in adolescence, most often in girls. It is common, bilateral and never spreads to other joints.

3. *The Big Toe.* Gross osteo-arthritis leading to hallux rigidus comes on during adolescence, almost wholly in young men. It is bilateral; other joints do not become involved.

The development of osteo-arthritis at these three sites is a remarkable phenomenon; for it is not elsewhere a bilateral disorder of young persons.

OSTEO-ARTHRITIS AND PAIN

The really remarkable fact about osteo-arthritis is that at some joints it hurts, at others not. A list follows:

Cervical spinal joints the capsular contracture appears painful, in so far as stretching the capsule out abolishes the symptoms Mere osteophyte formation sets up no symptoms

Sterno-clavicular joint usually causes a good deal of aching

Acromio-clavicular joint usually symptomless

Shoulder joint symptomless, as such, but predisposes to a superimposed traumatic arthritis after minor jarring

Elbow joint movement is limited lastingly, aching after excessive exertion is slight and evanescent. Loose bodies often form and cause attacks of painful internal derangement.

Radio-ulnar joint symptomless.

Wrist joint symptomless except in the advanced case.

Trapezio-first metacarpal joint considerable pain.

Finger joints only slight symptoms after many years Each node hurts while it is forming

Thoracic joints symptomless. If the disc wears completely away and the anterior aspects of the vertebral bodies touch, considerable lasting aching may result. Internal derangement hurts of course, whether osteophyte formation is present or not

Lumbar intervertebral joints not only is osteophyte formation entirely painless but it is highly beneficent, limiting movement and cupping the disc, this prevents the very attacks of internal derangement that would otherwise cause pain.

Hip-joint nearly always painful, or very painful

Knee-joint except in very advanced cases, there are no symptoms, these are caused almost entirely by impaction of a small cartilaginous loose body This is the explanation of the 'acute episodes' that are supposed to be due to osteoarthritis at the knee.

Ankle-joint considerable pain.

Tarsus seldom any symptoms

Big toe joint painful only if less than 45° range of extension is possible at the metatarso-phalangeal joint.

Other toes symptomless

TREATMENT OF OSTEO-ARTHRITIS

The treatment of osteo-arthritis, provided that it causes symptoms, is in the first place the treatment of the capsule of

the joint. In early cases and those of moderate severity, stretching out under heat analgesia is the keystone of treatment. At small joints, such as the interphalangeal, deep massage can be used to prepare the joint for the forcing of movement, but at the larger joints the power of the human hand is not great enough to have an appreciable effect, moreover, at some joints the capsule is quite out of reach.

In advanced cases the above type of treatment may be attempted, but usually fails. Physiotherapy then gives way to orthopædic measures, *e.g.* arthrodesis or arthoplasty, or the provision of a splint, a support, a caliper or a crutch.

Internal derangement complicates osteo-arthritis at the cervical, elbow and knee joints. In such cases manipulative reduction is required.

THE INFECTIVE ARTHRITIDES

These comprise three similar but not identical disorders: rheumatoid arthritis, infective arthritis and spondylitis deformans. Their nomenclature is unsatisfactory and their points of identity are no clearer than their points of difference.

RHEUMATOID ARTHRITIS

When multiple arthritis starts in the small joints, especially of the fingers, wrist and tarsus, it is called rheumatoid arthritis. Fusiform swelling of the proximal interphalangeal joints of the fingers is characteristic, as is a rather more rounded soft thickening of the capsule of the metacarpo-phalangeal joints, especially the second and third. At the wrist puffy soft swelling is also very obvious. Unless arrested, whether by treatment or spontaneously, the disease spreads proximally, tending to affect the elbows and shoulders, tarsi, knees and hips, often more or less symmetrically At the knees and elbows the capsule may become an inch thick and the joint often contains some fluid as well. The spinal, temporo-mandibular and ankle joints, and the joints at each end of the clavicle, are often spared.

Pathology

Rheumatic inflammation occurs, of course, in rheumatic fever and chorea A similar type of inflammation has been found in rheumatoid arthritis In the U.S.A. Curtis and Pollard (1940) carried out biopsies on skin and muscle from patients with this disease and showed that small foci of round cells of the chronic inflammatory type were present In 1942 Freund *et al.* demonstrated similar nodules on the nerve-sheaths In England, Gibson, Kersley and Desmarais (1946 and 1948) confirmed these findings, and further proved that they were absent from patients suffering from spondylitis deformans They showed that local degenerative changes affected the axons and medullary sheaths of the nerves close to these lesions they also demonstrated an increase in the interstitial connective tissue accompanied by extreme thinning of muscle fibres. These findings were once more confirmed by Morrison *et al.* at Harvard in 1947 They also are absent in spondylitis deformans There exists thus no doubt that rheumatoid inflammation affects a number of the fibrous tissues of the body By contrast, what has been called primary rheumatic inflammation of muscle and fascia (fibrositis, fascitis ") does not occur

Physical Signs

During the acute stage, the joints are hot, swollen and movement is limited by muscular spasm Low fever may continue for months in some cases enlargement of the spleen with amyloid change (Beattie, 1896) has been recorded Considerable loss of weight often heralds the attack and patients gain weight again when their joints improve. Pallor, which the blood count shows to be due to a microcytic anæmia, is common in cases of any severity The disease may regress at any time within the first few years, leaving the patient entirely well or with a minimal degree of structural alteration such as some ulnar deviation of the fingers or an increased extension range at the proximal interphalangeal joints. Alternatively, it may progress to complete crippledom with fibrous ankylosis of almost every joint. Often it does neither, but enters a chronic stage with subacute exacerbations lasting

some weeks or months, and continues this alternating course indefinitely. This tragic disease may start at any time of life; in my experience patients may develop typical lesions for the first time as early as three years old or after the age of seventy.

The capsules of the affected joints are by no means the only fibrous structures affected in rheumatoid arthritis. The tendon-sheaths may thicken, particularly at the wrist. Palpable nodules form on the tendons, especially in the palm. Bursitis with thickening and effusion occurs, usually near affected joints. The paræsthesiæ that are often experienced in the fingers and feet have been shown by the careful research of Freund *et al.* to be associated with nodules in the sheath of the peripheral nerves, pressure from which doubtless caused the symptoms. They appear specific, since they were absent in all of 84 control cases. Rheumatoid fibromyositis is also found on microscopy of excised tissue. The inference may be drawn that rheumatoid arthritis is a generalized affection of the fibrous tissues of the body in which the chief and most obvious incidence is upon the capsule of joints

The diagnosis of rheumatoid arthritis is usually only too distressingly easy. In very early cases, stiffness of the hands on waking is often the only complaint; no physical signs may as yet be detectable. The marked rise in the sedimentation rate that regularly accompanies early rheumatoid arthritis prevents mistakes. Gouty arthritis of the fingers in elderly men presents a very similar picture, distinguishable chiefly by estimation of the uric acid content of the blood. However, this fluctuates, and at times lies between 3 and 4 mgr. even in long-standing cases. Therapeutic testing by colchicum often provides the clearest criterion, in the absence of tophi or a clear family history. Sclerodactyly may be mistaken for rheumatoid arthritis, but the trophic change, the red and shiny skin stretched over the tapering fingers, should lead to a search for patches of scleroderma elsewhere. Post-traumatic osteoporosis is distinguishable by the clear traumatic history, the blue and white circulatory changes, strict confinement to joints distal to the injured site, and the marked disuse atrophy visible on the radiograph in the absence of appreciable disuse. The knobbly appearance and the incidence first upon the distal interphalangeal joints in osteo-

arthritis of the fingers makes error most improbable. The serological tests for syphilis and gonorrhoea should be performed as a routine, they very seldom prove positive.

Treatment

Cortisone and its analogues apart, treatment has little effect on rheumatoid arthritis One third of all patients recover spontaneously a fact that has given an appearance of effectiveness to many supposed remedies

The most important point is to ascertain that the patient s symptoms really are caused by rheumatoid arthritis It by no means follows that a patient with rheumatoid arthritis in the hands is suffering from spread to the joints of the toes when the feet begin to ache. Ordinary metatarsalgia, easily curable on standard lines, may have supervened. Rheumatoid thickening of a digital flexor tendon may lead to the trigger phenomenon, or even to complete loss of the capacity fully to bend the thumb or one finger This is curable by a minor plastic operation, just as if rheumatoid arthritis were absent. Supports can protect tender metatarso-phalangeal joints from excessive weight bearing

Hydrocortisone The advent of hydrocortisone will have a far reaching effect in widening the scope of orthopædic medicine It possesses the same anti inflammatory effect as cortisone, but exerts a local action Hence (though it can be given by the mouth or by injection for its systemic effect) hydrocortisone can be applied wherever it is needed in small amounts at infrequent intervals Constitutional reactions are thus avoided. The relevance to rheumatoid arthritis is obvious, and intra articular injection, if the condition is not too widespread, is the treatment of choice

Inflammation is inhibited as much in cases following injury as in the rheumatoid disorders Since the cause of traumatic inflammation is not a persistent condition, relief, once it is achieved, is lasting By contrast, the cause of rheumatoid arthritis goes on, and reactivation of the inflammation has to be prevented by treatment continued indefinitely But, in the small dosage employed at each joint, this has proved simple and devoid of danger in patients with only a few joints affected. For example 50 mgr

injected once a fortnight has served to allay severe infective arthritis at the knee; 25 mgr. injected on two or three occasions can destroy pain and increase range in infective arthritis at the shoulder. An injection of 10 to 15 mgr. can be relied upon to cure most cases of teno-periosteal or tendinous tennis-elbow.

All the applications of this delightfully simple but effective measure are not yet worked out, but it is already clear that much painful scarring, especially in tendons, which the physiotherapist's finger has slowly and painfully broken down, can be treated by the anti-inflammatory action of hydrocortisone (Cyriax, 1953). Quite possibly, too, an important bearing on orthopædic surgery will be found. Introduced into the knee-joint, say, after meniscectomy, the hormone will serve to abort the subsequent traumatic arthritis and thus materially shorten post-operative convalescence. It will be interesting to see whether, after a sprain of, for example, a collateral ligament at the knee, it suffices to introduce the suspension merely into the knee-joint or whether better results follow infiltration of the actual site of the ligamentous injury. Certainly, injected into the knee or shoulder before manipulation under anæsthesia, hydrocortisone largely abolishes the subsequent painful reaction. It may well prove beneficial on injection into the pleural and pericardial cavities, and will doubtless be tried locally in allergic rhinitis

If non-specific lesions of joints, ligaments, bursæ and tendons can be brought under immediate control by this hormonic means, much of the work now carried out laboriously by physiotherapists can be simplified or even avoided altogether. By contrast, the importance of a precise diagnosis will be further enhanced. The width of the physiotherapist's finger allows the physician a latitude of almost 1 cm. whereas an injection of 0 5 to 1 c.c. has to be placed with much greater exactitude. The properties of hydrocortisone, however much of deep massage they supplant, will not affect the practice of manipulation. Displacements will still need to be reduced, and adhesions, once formed, will still have to be ruptured. Indeed, it becomes possible to manipulate joints more freely now that hydrocortisone can be relied on to prevent the subsequent reaction.

Myocrisin Until cortisone and ACTH become widely available, gold salts will doubtless continue to hold a place in treatment. Provided no toxic signs appear a total of one gram of myocrisin in saline solution (i e half a gram of metallic gold) can safely be injected in the course of three months The weekly-dose is 0·01, 0·02, 0·05 and nine injections of 0 1 gm. In adolescents or the elderly a dose of 0 05 gm. should not be exceeded The urine is examined for albumin before each weekly injection. Early signs of intolerance are albuminuria, small ulcers in the mouth or a skin rash usually appearing first at the wrists. At the slightest toxic sign the injections must be stopped In spite of these precautions, severe reactions such as extensive dermatitis occur nevertheless in about one per cent of all cases treated with gold Full recovery from the toxic manifestations is to be expected under treatment by BAL. A palpable spleen contra indicates chrysotherapy Another course of gold may be given after three months if the first was followed by alleviation

Butazolidine This drug is proving invaluable in the relief of pain due to articular disorders otherwise intractable It relieves pain in rheumatoid arthritis, spondylitis deformans and osteo-arthritis. The curious fact is that the joint signs (*e.g* local warmth, capsular swelling and limited movement) persist unaltered whereas the pain and subjective stiffness are relieved. The effect, since it is not local, must be presumed to be cerebral, as in the case of other analgesics. But its action appears selective, in so far as the drug is particularly effective against articular pain and no impairment of mental activity is noted In my (as yet, small) experience, the dosage recommended is too large One 0 2 gm. tablet should be taken three times a day for a week. If little relief follows, treatment by butazolidine should be stopped If, on the contrary the symptoms abate, the dose should be reduced to one tablet a day If this amount suffices, it should be continued indefinitely So far by observing this cautious routine, toxic reactions have been avoided Osteo-arthritis of the hip and chronic spondylitis deformans appear particularly responsive to these small doses

Butazolidine must not be given to patients with a history of peptic ulcer Re-activation of the ulcer is highly probable and gastro-intestinal hæmorrhage a likelihood.

Toxic reactions leading to abandonment of treatment occur in about a quarter of all patients treated with the usual higher dosages. The important complication is aplastic anæmia, of which several fatal cases have been reported. Since butazolidine is akin chemically to amidopyrine, agranulocytosis is not an unexpected possibility. Less serious troubles are rashes, nausea, abdominal pain, sore throat and œdema of the ankles. The œdema results from salt-retention and is avoidable by a salt-free diet.

Spa Treatment. This has obvious advantages for the more severe cases. The patient lives at the place where treatment is carried out and can thus receive attention for several periods daily. Rest can be enjoined without interference from workaday duties. It is not, of course, the drinking of this or that water, but the discipline, the nursing, the diet, the wealth of therapeutic apparatus available and the presence of medical men and physiotherapists skilled in every type of rheumatoid disorder that makes for amelioration. Spa treatment consists of rest and making sure that the patient uses to the best advantage such movement as he has retained. Naturally a bedridden or greatly disabled patient may, on account of pain and rigidity at some joints, make less than full use of other joints. These may thus become stiffer than can be helped, whereupon muscle power also dwindles unnecessarily. Treatment of each joint in turn while the body is supported in a brine bath facilitates the restoration of mobility; muscle power begins to return. Gentle passive leading to active movements, faradism to the muscles, and heat to the joints all contribute to ensure that the disablement is reduced to the unavoidable minimum. Exercises, occupational therapy and an atmosphere of interest and encouragement are vital to the achievement of the best results.

INFECTIVE ARTHRITIS

When one of the larger joints of the body, for no apparent reason and in the absence of bacterial infection, develops pain, synovial swelling, warmth and limitation of movement, the condition is named infective arthritis. Had the same condition—to all appearances—begun in several of the smaller joints of the hands or feet, it would have been called rheuma-

toid arthritis. The knee, hip shoulder and elbow joints may be affected, usually singly or at the two symmetrical joints A few cases of infective arthritis progress until the small joints are affected as well, the resemblance to rheumatoid arthritis is then complete. More often the course of the disease is much more benign, and after several months improvement begins, often leading in less than a year to full recovery Some or many years later the disease is apt to recur in the same or other joints, recovery is again the likelihood.

The diagnosis between monarticular infective arthritis and tuberculous infection is sometimes difficult The radiographic appearances are usually distinctive, but occasionally diagnostic synovectomy or the removal of a lymph gland may be required The border line between villous and advanced infective arthritis is so indistinct as to make me think that these two conditions are identical, the question being only one of degree In acute gonorrhœal arthritis the fact of bacterial invasion is obvious, but in chronic milder cases there are no distinguishing features, except, if the patient is honest, the history If at a mixed clinic the blood tests for gonorrhœa and syphilis are performed in all cases of infective arthritis as a routine, positive results turn up quite rarely (about one per cent in civilian practice in London)

Treatment of the early case consists in intra articular injection of 10 mgr of myocrisin. Repeated two to four times at weekly intervals, this treatment clears up many other wise intractable cases, especially at the knee. If myocrisin fails, hydrocortisone should be tried by intra articular injection. If still no lasting benefit accrues, splintage is the only alterna tive, apart from awaiting the passing of time Arthrodesis may be required.

SPONDYLITIS DEFORMANS

This disease differs from the two previous types of infective arthritis by the supervention in due course of ossification in the soft articular structures and by its inexorable progress from the sacro-iliac joints, up the vertebral column, to the neck. The disease often spreads to the hip-joints, seldom to others, if it does, the final picture may reproduce the characteristics of multiple rheumatoid or infective arthritis. Men

are eight times more often affected than women and the disease usually begins between the ages of seventeen and thirty. Sacro-iliac arthritis does not begin after the age of forty, and runs a benign course, especially in women, if the onset occurs after the age of twenty-five. The sedimentation rate is often raised during the chronic stage as well as during a flare.

The response to active treatment in spondylitis deformans is also different from that in rheumatoid or infective arthritis. Whereas physiotherapy is harmful in the acute and subacute, and of little avail in the chronic stages of the latter, the joints in spondylitis deformans may respond reasonably well to repeated forcing of movement by the physiotherapist. While *immobilization in a good position is required if the spinal* disease progresses rapidly in a young patient, active treatment begun as soon as the exacerbation subsides is most successful in relieving pain for the time being. Furthermore, deep x-ray treatment, which is often so successful in destroying the pain of spondylitis deformans, does not afford comparable benefit in rheumatoid and infective arthritis. No measures now known prevent the eventual evolution of the disease, but treatment by forced movement and x-rays makes life very much more bearable to the patient for many years (see p. 506). The disease may evolve painlessly, being discovered only when a patient complains that he cannot look behind him because of stiffness of the neck. In chronic cases, butazolidine often brings great subjective relief.

TREATMENT OF GOUT

Patients who develop gout nowadays are seldom suffering from excessive drinking and meat-eating. Hence, not much can be expected from the avoidance of alcohol and purine-containing foods—kidney, liver, sweetbread and fish-roe.

Colchicine 1 mgr every four hours remains the stand-by during the acute attack, which is reliably aborted in a day or two. This dosage is continued until the symptoms cease altogether, *i e.* three to five days. Diarrhœa is often set up on the third day. Rarely patients get such indigestion that they cannot take colchicine; if so, it can be given by intravenous injection. Cortisone is not to be recommended, for

its withdrawal results in recrudescence of the acute arthritis Butazolidine appears to exert a true anti-gouty effect, not just the analgesic action that is its main virtue in other arthritic disorders It has been shown (Wyngaarden, 1955) to increase the excretion of urates in the urine

Between attacks, salicylates are called for to enhance excretion and lower the uric acid level in the blood They should be given indefinitely in a daily dose of 6 gm Another approach is via the renal tubules by means of benemid (0 5 to 1 gm daily) Benemid diminishes reabsorption of uric acid from the glomerular filtrate and like salicylate, keeps down the level of uric acid in the blood for as long as administration continues As a result, the attacks become less frequent and less severe Benemid and salicylate must not be given together as they inhibit each other's effect (Pascale, 1952)

CHAPTER VI

THE DIAGNOSIS OF SOFT TISSUE LESIONS

BEFORE this discussion on diagnosis, it may be profitable to attempt to define the scope of the diagnostic aspect of orthopædic medicine. Certain negative considerations appear immediately. Electrotherapy deals with a wide field of disorders. Every sort of septic condition, surgical and medical, reaches the department; patients are sent from the children's, the eye, the ear, the nose and throat, the skin and the gynæcological departments in large numbers. It is clear that no one man could make himself fully conversant with the intricate details of electrical methods and with the subject of diagnosis with a view to electrotherapy, if only because this would entail, besides mastery of his own subject, equally deep knowledge of the whole field of medicine, surgery and the specialties. Practitioners of physical medicine thus tend to fall into two classes: those who devise and perfect electro-therapeutic and electro-diagnostic apparatus and investigate its uses, and those who concentrate on the clinical examination of patients and on their treatment by physical methods—notably massage, manipulation, traction, local anæsthesia and exercises. It is to the latter practitioners that I feel that the term "orthopædic physician" properly applies

The clinical aspect of the work of a department of physical medicine consists largely in the diagnosis and treatment of soft tissue lesions. Lesions in the moving parts occur throughout the body, and the symptoms may mimic a number of visceral or neurological diseases. Diagnosis, leading to exact treatment, presents problems whose clarification is not covered by the scope of any other department, though the work of the neurological and orthopædic clinics fringes and overlaps to some extent. In purely orthopædic and neurological cases the patient arrives at the physiotherapy department with a clear diagnosis: there is no doubt about the site of a fracture, or the nature of the operative intervention, or of the type of a nerve-lesion, from which recovery is to be

promoted. It is therefore mainly in non surgical conditions affecting the soft tissues of the body, *i.e.* the fibrosis in moving parts that follows upon overuse or injury, the various disorders affecting joints, and pressure on the sheath of nerves, nerve-roots and dura mater, together with their differentiation from other diseases, that the orthopædic physician exercises his diagnostic capacity. This affords him the widest scope in an interesting and largely uncharted field of medicine.

One of the two main characteristics of deeply-seated lesions is the lack of correspondence between the site of the pain and the site of the lesion. Hence the physician must define the source of the identical diffuse pains that may arise equally from muscle, tendon, joint-capsule, ligament, bursa, dura mater and nerve-sheath. The other outstanding feature of such pains is the paucity of objective physical signs to which they may give rise; hence diagnosis may rest largely on the correlation of a series of subjective statements. This requires practice. Nevertheless, no effort must be spared to reach an exact localization of the source of each pain, since treatment cannot usefully be begun until the site and nature of the causative lesion have been precisely defined. For example massage, unless applied to the exact site of a lesion, can do no good. No less accuracy is essential when local anæsthesia is employed, since the solution must be introduced at some definite spot. Likewise, when manipulative measures are contemplated, the site of the lesion and its type determine whether or not they are indicated and what form they shall take.

This chapter describes the principles of a system of diagnosis that reveals the origin of a pain in a high proportion of cases no matter where the symptoms happen to be perceived. The approach is purely mechanical and leads to full anatomical—though not always pathological—definition of the site of a painful lesion. By a logical process many complex painful movements are resolved into a number of simple components, each of which is then tested separately. This is an approach almost mathematical in its precision and is suited to the mechanical function of the structures under examination.

The patient's co-operation is essential. He is asked to state which movements hurt and which do not, while being steered away from lengthy digressions on where the pain is felt and

what sort of pain it is. This makes diagnosis the more difficult in acute cases in which there is pain in the absence of movement; for it is clearly hard for a patient to tell what movement hurts him when he is already in constant pain To get a patient to perform a series of movements at several joints, to say which hurt, and to let the responses build up a pattern in the examiner's mind; to perform special tests for certain structures; to search for tenderness of the structure identified—if it is accessible; to induce local anæsthesia at the chosen spot and to await the patient's verdict—all this must obviously take a long time. In complicated cases, even those accustomed to such work cannot afford to hurry. The first essentials, therefore, are plenty of time and patience, and the perseverance to examine patients repeatedly until full accuracy is achieved.

At any examination of which the patient's co-operation forms part, the opportunities for deception are many. Since in many cases the only final criterion of a correct diagnosis is the induction of local anæsthesia—the response to which is often a subjective phenomenon—the physician should be on his guard against feigned illness; for patients have learned that the symptoms least capable of objective evaluation are those with which the orthopædic physician most often deals. Thus, while it is no substitute for a diagnosis to regard all patients with obscure pains as having minor disabilities, a balance must be maintained between credulity and excessive scepticism.

OBJECTS OF DIAGNOSTIC MOVEMENTS

Diagnosis in soft tissue lesions must be approached indirectly. No physician would regard palpation of the chest as the chief method of diagnosis in heart disease; even less would he regard the discovery of an area of intercostal tenderness as of localizing value. Function is tested by remote signs: *e.g.* feeling the pulse, ascertaining the blood-pressure and so on. In just the same way, immediate palpation must be avoided in locomotor disorders. The state of a joint, muscle or nerve is assessed by discovering how well or ill it functions; palpation may or may not follow.

The primary object of the diagnostic movements described here is to discover where, *i.e.* about or at which joint, the symptoms arise. This is by no means as easy as might be expected. Once this has been ascertained the distinction must be made between lesions occurring in the *contractile* and in *inert* structures about that joint. By "*contractile*" is meant those structures that form part of a muscle—namely the belly itself, the tendon, and their bony insertions. From contractile structures pain may be elicited both by active contraction and by passive stretching. It must be remembered that pain on resisted contraction is caused also when (1) a fracture lies close enough to a muscular insertion for the strain to be transmitted to the break. (2) when an inflamed lymphatic gland or an abscess lies directly under a muscle. By "*inert*" is meant those tissues that have no power of active contraction and from which pain can be provoked only by stretching. From the point of view of the orthopædic physician these are: joint-capsule, ligament, bursa, dura mater, nerve-root and nerve sheath.

Positive signs must always be balanced by corroborative negative signs. If a lesion appears to lie at, or near, one joint, this region must be examined for signs identifying its site. It is equally essential for the adjacent joints and the structures about them to be examined so that, by contrast, their normality can be established. These negative findings then reinforce the positive findings emanating elsewhere; then only can the diagnosis be regarded as established.

If the movements show the lesion to lie in a contractile structure, tests can be devised that disclose which one of several possible muscles is involved, sometimes even which part of it. If the movements show the lesion to lie in an inert structure, a decision is required on whether all the structures limiting movement at a joint are involved (*i.e.* a diffuse capsular lesion), or only a small part of them (*e.g.* a ligament). If a single inert structure is found at fault, its position, whether articular or extra articular, requires definition.

Finally, by a correlation of the symptoms and signs, a decision is arrived at on the stage that the lesion has reached. In some conditions, *e.g.* internal derangement of a joint or a minor muscular rupture, the treatment is the same whether

the condition is acute, subacute, or chronic, whereas at other sites treatment on very different lines is required (*e.g.* arthritis or ligamentous strain).

Needless to say, the performance and interpretation of diagnostic movements lie exclusively within the province of the medical practitioner, but the physiotherapist when assessing the effectiveness of treatment has to use the same tests; hence she must be acquainted with the way in which they are employed. No one can safely neglect the essential information thus afforded, particularly when a lesion of a deeply-placed structure is in question. In such cases, the indirect method is particularly valuable; for the nature and position of the faulty structure are then a matter of deduction rather than palpation. Moreover, in no other way can the ubiquitous phenomenon of referred tenderness be prevented from misleading the examiner.

EXAMINATION IN SOFT TISSUE LESIONS

HISTORY

This may be important, particularly in traumatic cases. A few conditions give rise to a series of symptoms pathognomonic in themselves, *e.g.* intermittent claudication. *The best approach is chronological,* the patient being asked about the events leading up to the first time his symptoms came on, and then asked to recount week by week, or year by year, what has happened since.

Naturally the age, sex and occupation of the patient are noted first, and the patient is asked if this is the first time his symptoms have arisen. A lengthy history rules out conditions such as cancer; recurrent trouble at a joint occurs in rheumatoid arthritis and when an intra-articular loose body is present. Occupation occasionally provides a pointer to diagnosis, *e.g.* in industrial hazards, and has an important bearing on treatment, especially in recurrent disorders such as internal derangement, or on management in a progressive disease like spondylitis deformans

In traumatic cases the patient should be asked for a description detailed enough to enable the examiner to visualize

his posture at the moment of the accident and thus to deduce the direction of the strains operating on the injured part The events during the period immediately after the accident must be described Disablement follows at once after trauma to bone or joint, whereas minor muscular tears usually become troublesome only after some hours If the injured joint has an intra-articular meniscus or if the presence of a loose body is suspected, the occurrence of giving way, locking unlocking and clicking should be noted Whether the joint locks in the extended or flexed position must be ascertained Sudden twinges occur when a loose body in a joint subluxates, they must be differentiated from the stabs of neuralgia or tabes and the sudden painful inhibitions of muscle contraction resulting from myotendinous strains. The patient should be asked about bruising and swelling and the speed of appearance of effusion into a joint noted. A clear effusion takes at least several hours to accumulate whereas blood fills the joint in a few minutes Enquiry is made of variations in the pain and degree of disability between the time of the accident and when the patient is first seen. The history is characteristic in many traumatic conditions, *e.g* dislocation of the meniscus at the knee, jaw or any spinal joint tearing of some of the fibres in the gastrocnemius muscle

When somatic pain arises without apparent cause, the patient should nevertheless be asked to what he attributes the onset Occasionally valuable information is gained thus, though much of patients' theories on ætiology is wide of the mark. The nature of the overuse that preceded the symptoms may prove significant, particularly in spinal and in tendinous lesions. The place where the pain was first felt is often a good guide to its source, especially in arthritis and affections of a nerve-root, for in both disorders the pain may wholly leave the actual site of the lesion and be projected distantly as the condition progresses A sudden, apparently causeless attack of severe pain in the scapular or lumbar region may characterize disc-protrusion, and the subsequent typical migration of the pain may afford a clear pointer to the diagnosis. In lumbago and acute torticollis a sudden, unprovoked onset of pain severe enough to immobilize the affected part is quite typical

The practitioner of orthopædic medicine has to distinguish

between only two qualities of pain: the aching, burning or throbbing pain characteristic of any somatic, nervous or vascular lesion and the sensations of tingling, pins and needles and numbness that occur distally only in affections of the nervous and circulatory systems. Whereas the presence of paræsthesiæ strongly suggests that the lesion affects a nerve, their absence provides no contrary evidence. If the tingling is caused by circulatory disturbance, the distal part of the limb alters in colour. When paræsthesiæ are felt enquiry must be made of their exact site; for they may occupy a peripheral nerve area and thus identify the affected nerve. By contrast, they may affect an area that does not correspond to any peripheral distribution and thus indicate that the lesion lies high up, before the plexus is fully differentiated. If the patient can tell whether the front or the back of a finger feels paræsthetic, the lesion lies below the shoulder-joint.

When pins and needles, especially if they are felt bilaterally, occupy an area corresponding neither to the distribution of one peripheral nerve nor to the dermatome relevant to one nerve-root, pressure on the spinal cord should be suspected. In other words, just as pain referred extrasegmentally suggests pressure on the dura mater, pins and needles projected extrasegmentally suggest pressure on the spinal cord.

The antithesis between the symptoms of pressure on a spinal nerve-root and pressure on a nerve-trunk must be kept in mind. Irritation of a spinal nerve-root gives rise to pain felt in the trunk (dural pain), later spreading to a limb. After some time, pins and needles may be felt distally. By contrast, pressure on a nerve-trunk, no matter where it is exerted, leads to distal paræsthesiæ when the pressure abates; little or nothing is felt at the point of impingement.

The patient must always be asked if the pain spreads at all, and if so, where to. A patient often neglects to mention, unless specifically asked, a small degree of distant reference of pain. If he can outline it at all accurately, the distal extent of a pain defines the dermatome which it occupies. Once the segment has been identified, the field has narrowed. The mere fact that reference is to a limb rather than to some part of the trunk, serves to distinguish between two groups of segments. Since symptoms are referred chiefly distally, the proximal extent of a pain may be taken as the point at or

above which to look for its source. When any part of the trunk is examined, the patient must be asked whether the pain is central (or equal on the two sides) or unilateral. Most bilateral pains have a central origin the thoracic outlet syndrome is a notable exception.

The relationship of pain to activity rest and posture should be determined The pain of muscular, tendinous, capsular and ligamentous lesions is brought on or increased by movement and, except in severe arthritis, is mitigated or absent when the part is kept still. In articular disorders the presence of pain when the joint is kept at rest is one of the criteria by which to assess whether or not the lesion is active In addition to pain on exertion, stiffness after the joint has been kept still for some time is often mentioned in osteo-arthritis, especially if a loose body is present in the joint. The patient should be asked if a deep breath, coughing or sneezing affects his symptoms. If the pain is felt in a limb, aggravation by coughing strongly suggests that the lesion is intraspinal if the pain is felt in the trunk, it must be remembered that a number of different lesions give rise to pain on coughing *e.g* pleurisy, a fractured rib, minor rupture of an intercostal or oblique abdominal muscle, a diseased kidney sacro-iliac arthritis, and a small spinal tumour (of which a protruded disc is only one variety)

When pain in the trunk is under consideration, its relationship to posture, exertion and rest is naturally explored This approach from one side only is not enough, and the existence or not of phenomena suggesting a visceral origin should also be ascertained. The rhythmical increase and subsidence of colic, unrelated to any bodily movement, is characteristic. The effect of eating hunger and defæcation (which may hurt also in a lumbar disc-lesion or in coccygodynia) should be noted, together with any symptoms suggesting a disorder of the urinary tract, or in women, of the pelvic organs The fact that a patient declares her backache to be more severe at the time of menstruation does not prove that her pain originates in the uterus for in such a case uterine referred pain may merely superimpose itself indistinguishably on a backache arising from the back. Pain in the trunk elicited by neck flexion designates a lesion involving the dura mater, but paræsthesiæ evoked in one or both lower limbs by

neck-flexion are an early sign not, as might be expected, of a lumbar but of a cervical or thoracic intraspinal lesion lying centrally.

In joint lesions enquiry should always be made for involvement, past or present, of other joints. This may bring to light information helpful in arriving at a diagnosis of infective, rheumatoid, spondylitic, gouty or gonorrhœal arthritis. In gout, the family history may be suggestive.

In spinal nerve-root pressure the pain may be constant day and night and is sometimes unrelated to exertion; such movements of the limb as do not stretch the affected root are apt if anything to relieve the symptoms for a short time. Heat diminishes most pains but often aggravates that caused by root-pressure or intermittent claudication.

Another virtue of a full history is the excellent warning that it gives to the examiner on when to be careful. Patients with common disorders give an account of their vicissitudes with little variation between one patient and the next. The physician recognizes the familiar story, and confirms the diagnosis after a thorough examination; but he cannot, especially in an out-patient clinic, always investigate every system in the body. A history noted to differ markedly from the typical arrests the listener's attention and puts him on his guard—partly against feigned illness, partly against disorders with which orthopædic medicine does not deal, and partly against a condition, properly sent to his department, with which the physician is so far unfamiliar.

To summarize: the most important points in the history are the events that led up to the appearance of pain, where it was first felt, especially whether on one or both sides of the body, whither it has spread since, what it feels like, and what is its relation to rest and exertion.

INSPECTION

This reveals the attitude in which the part is held; some positions are in themselves characteristic, e.g. the hand supporting the other elbow in fracture of the clavicle. Bony deformity, e.g. genu varum and [illegible] al postures such as torticollis or scolio[illegible] The presence of general or local s[illegible] and of changes

in colour of the skin are noted, especially if colour changes can be induced by dependence or elevation.

Inspection also discloses the type of gait, at times a most important finding especially in internal derangement at the knee, arthritis at the hip spastic diseases and hysteria

PALPATION

The dorsum of the examiner's hand detects variations in temperature better than his palm Localized warmth should be sought, and care taken that the recent removal of a bandage or the application of a rubrifacient ointment does not deceive Apart from bacterial infection the detection of heat means that, whatever the lesion present, it is in the active stage Heat is present therefore after an operation on a joint, during the stage of active healing of the divided tissues. Heat unaffected by rest is present after a ligamentous sprain or over a broken bone, if it lies superficially, as long as active healing continues If adhesions exist, or an impacted loose body lies displaced in a joint subjected to weight bearing, heat ensues which is quickly abolished by rest. Hæmarthrosis is always accompanied by heat, and, if the joint is tense with blood, gross limitation of movement. In all these conditions, there is no synovial thickening In active gonorrhœal gouty rheumatoid, infective or spondylitic arthritis, heat is present in conjunction with synovial thickening A superficial malignant deposit eroding bone (*e.g* a rib) may feel warm.

Palpation reveals the size, behaviour and consistency of any swelling and whether there is fluctuation or not. Œdema may pit. Loose bodies may be made to move about inside a joint cavity or a tendon sheath Localized swelling of a tendon, osteophytes, a bursa, a cyst or a ganglion, are all readily felt. Whether or not a muscle is capable of voluntary contraction may be discernible only to palpation, this also discloses the presence or absence of pulsation in an artery, the extremity of the limb may feel cold to the touch

Abnormal sensations may be imparted to the examiner's hand on movement at a joint, *e.g* clicking or crepitus

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Again, the examiner is partly dependent on the discovery of an incongruous pattern and on inconsistencies in the patient's replies for the recognition of pain devoid of organic basis.

Errors in localization are easy enough to make in soft tissue lesions examined under the best conditions ; in hospital practice, where patients are not always either quick to grasp what is wanted of them or explicit in their answers, the temptation to shirk some part of the examination may be great. It must be resisted, for much time is wasted if the patient is sent for treatment based on an inadequate diagnosis. The patient must not be flustered, for time is lost, not gained, by hurry and an unsympathetic manner. The examiner should remember that in this field diagnosis depends largely on the correlation of the history (a subjective statement) with the responses to a series of movements (again subjective). Unless the patient is made to realize what is required of him, there is little hope of reaching a correct diagnosis in other than simple cases

The least reliable way to attempt diagnosis in soft tissue lesions is to palpate immediately for tenderness in the area outlined by the patient. Though this method has occasional success, it is most unsatisfactory, partly on account of the misleading phenomenon of referred tenderness, partly because the region outlined by the patient by no means necessarily contains the lesion, partly because many spots are normally tender and partly because successful deception by allegations of feigned symptoms then becomes inevitable Hence, it may once more be emphasized that indirect examination by means of testing different types of movement forms by far the most important constituent of any attempt to localize a soft tissue lesion.

The orthopædic physician must be ready to examine patients repeatedly. If a patient suffering from a relievable lesion fails to improve after three weeks' treatment, it is my practice to ask the physiotherapist if she has any reason to offer and whether she agrees with the diagnosis. I then re-examine the patient in her presence, to re-establish (or disprove) the diagnosis already arrived at. If the diagnosis proves justified, I then ask the physiotherapist to show me how she has been treating the patient, and any faults in technique

are thus ascertained and put right at once. In this routine the practitioner is very much at the mercy of his staff, for, should the massage have been given imprecisely in technique or site, or should some manipulation have been performed inadequately, he has to examine the patient all over again for no fault of his own. However, this is no real disadvantage, since it provides the only check that he has on the degree of aptitude with which the treatment ordered has been carried out.

SIGNIFICANCE OF DIAGNOSTIC MOVEMENTS

I ACTIVE AND PASSIVE MOVEMENTS ARE EACH PAINFUL IN THE SAME DIRECTION, AND THE PAIN APPEARS AS THE LIMIT OF RANGE IS APPROACHED

The resisted movements do not hurt this means that an inert structure is at fault.

Diffuse Capsular Lesion

If all active and passive movements are painful at their extremes—even more, if the range of movement is limited —the whole inert cuff about the joint is shown to be involved. In such cases the clinical picture of arthritis is seen, and the cause of the signs is a diffuse capsular contracture. It is only by realizing that arthritis and diffuse capsulitis are synonymous terms that the theory on which the diagnosis of arthritis is based can be understood In arthritis the whole capsule of the joint shortens hence every movement, since it stretches some part of the capsule, hurts towards its extreme and, in all but the slightest cases, is limited in range. In acute and subacute arthritis this limitation results from muscular spasm coming into play to protect the capsule from being stretched in osteo-arthritis it is the capsular contracture itself, hardly guarded by muscular spasm, that restricts range, in advanced disorganization of the joint, the bony outcrops engage. Whether the examiner stretches the patient's capsule for him, or the patient repeats this movement by using his own muscles, the degree of stretching and therefore the amount of pain produced, are the same.

In arthritis, at the extreme of the possible range, passive

movement of the joint comes to a dead stop, always at the same point, however often the attempt is made. The examiner should learn to recognize this "capsular feel," which is absent in limitation of movement due to bursitis, psychoneurosis or malignant disease. When important disease, e g. severe arthritis, cancer or tuberculosis, is present, he should learn to perceive the vibrant twang of muscle spasm coming into play to bring the movement to an abrupt stop. The "capsular feel" is one of passive arrest of movement whereas in spasm a much more active impression is given to the examiner's hand

The Capsular Pattern. When the capsule of a joint contracts, it does so in a manner varying from joint to joint, but hardly varying at all when the same joint is examined in a number of different patients Hence every joint has its standard pattern. When examination discloses the capsular relationship, the limitation of movement at the joint is termed "proportionate" For example, in arthritis at the knee 10° limitation of extension implies that about 90° limitation of flexion will be found; this is proportionate By contrast, 90° limitation of flexion accompanied by a full range of extension would be markedly disproportionate, as would 5° limitation of extension with a full range of flexion. Thus the reason why all the primary movements at a joint are tested passively is to enable a decision to be reached on what relationship exists between the amount of limitation found in each direction. *Proportionate limitation of movement designates an articular lesion, disproportionate limitation an extra-articular lesion or internal derangement.*

Since evidence of arthritis is often sought from examination of the radiograph, it is easy to get into the way of thinking of arthritis as an affection of cartilage and bone, and to adopt the view that, if the radiograph reveals no abnormality, arthritis must be absent. This attitude leads to grievous error. Erosion of cartilage, osteophyte formation and changes in the density of the bones may well be shown, but cartilage, having no nerves, is devoid of sensibility; osteophyte formation and rarefaction of bone are not of themselves painful These secondary phenomena are not vital to the clinical concept of arthritis, which displays itself primarily as a capsular contracture.

Localized Capsular Lesion

If some, but not other, movements at a joint are painful at their extreme or are limited, arthritis is necessarily absent, since *only* part of the *inert structures* about the joint is involved. In other words those movements that stretch the affected part of the capsule are painful and may be somewhat limited, those movements that do not, are full and painless A lesion thus shown to affect a small part of the capsule of a joint usually consists of adhesions about a ligament, these cause limitation of movement also of the proportionate type

Internal Derangement

This disorder occupies a position intermediate between proportionate and disproportionate limitation of movement, leading as it does to limitation of movement at a joint in some though not all directions Minor degrees of internal derangement lead to proportionate, major degrees to disproportionate limitation of movement. Disproportion is obvious in the classical case of displacement of part of the meniscus at the knee, when only extension is limited It also occurs in varying degrees at the lower cervical and lower lumbar joints where, depending on the size of the loose fragment and on the degree of intra articular subluxation, movement may be slightly or markedly limited in several directions, perhaps only one movement remaining of full range This finding is characteristic of fragmentation with displacement of part of an intervertebral disc.

Extra-articular Limitation

When an extra articular structure is at fault, disproportionate limitation of movement results By ' disproportionate " is meant *gross limitation of movement in one direction, with* a full range in other directions The most obvious instance of such limitation is a painful lesion of the quadriceps muscle in the mid thigh Flexion at the knee-joint may be limited by 90°, whereas the range of extension and rotation is full and

painless. When an extra-articular lesion sets up disproportionate limitation of movement, special diagnostic tests can always be devised. They depend on the discovery that the range of movement obtainable at one joint varies according to the position of another joint. The presence of such a relationship shows the lesion to lie within a structure that spans at least two joints; this clearly excludes any articular structure. For example, limitation of straight-leg raising but no limitation of hip-flexion when the knee is kept bent shows the lesion to lie in a structure passing from behind the hip-joint to below the back of the knee. The most extreme example of distant exertion of tension is provided by the head-and-knee test for the sciatic nerve-roots, in which flexion of the neck sets up a pain that can be relieved by bending the knee. This is an example of the *constant length phenomenon*, which is also found in ischæmic contracture, when the muscle bellies have lost their elasticity. Then too the position in which one joint is held determines the amount of movement possible at a neighbouring joint, *e g.* when the flexor muscles in the forearm are shortened, the fingers cannot be extended unless the wrist is flexed first.

2. PASSIVE MOVEMENT IS PAINFUL IN ONE DIRECTION AND ACTIVE MOVEMENT IS PAINFUL IN THE OPPOSITE DIRECTION

This indicates a contractile structure to be at fault, *i.e.* a muscle belly, a tendon, or the attachment of either to periosteum. Since tension is the cause of pain, passively stretching the muscle hurts; active contraction in the opposite direction also hurts. This finding leads to immediate trial of the resisted movements (see below).

The direction of the painful movement clearly indicates which group of muscles is involved. Accessory movements, picking out the various members of the group individually, define the affected muscle, and may even show which part of it is affected. When a muscle spans two joints, *e.g.* the muscles of the arm or thigh, special tests can be devised.

Exception. In acute teno-synovitis at the wrist, pain is set up when movement occurs between the roughened tendon and its sheath. Hence not only such movements as stretch

the tendon, but also those that relax it, set up a painful friction in the latter case by pushing the tendon down the sheath The occurrence of pain on those two passive movements might suggest a lesion of an inert structure at the wrist joint The diagnosis becomes clear only when the resisted movements are tried these cannot set up pain in an articular lesion.

8 RESISTED MOVEMENT CAUSES PAIN

If the resisted movements are tested with due care, they serve to confirm the presence of a lesion of contractile tissue. The following precautions must be observed *Firstly* the resistance must be applied strongly enough to prevent all movement at the joint. Pain felt when the patient attempts the required movement can have only a muscular or tendinous origin since the tension on no other structure is altered *Secondly* the joint must be at its mid position when the response to resisted movements is tried, for only thus can pain due to the stretching of inert structures be avoided *Thirdly* when the resisted movements are tested it is essential to try all the movements Each muscle group is tried in turn. The discovery of a full range of movement at a joint coupled with pain elicited by one resisted movement, or by two congruous movements, identifies a lesion within the group of muscles performing that movement.

Should all the resisted movements at a joint prove painful, the conclusion must be drawn that none of the contractile structures about that joint is involved, since in my experience a diffuse affection of all the muscles about a joint does not occur except from obvious gross damage. This finding should lead to examination of the structures situated proximally, which the patient has to brace before being able to attempt any resisted movement at the more distal joint. Alternatively the presence of the exaggerations characteristic of psychogenic disability should be considered

There exist two conditions not directly connected with muscle that nevertheless give rise to pain when muscle is tested against resistance The first is fracture of bone close to the attachment of muscle or tendon Naturally muscle pull tends to move the fractured ends on each other painfully

4. THE ELICITATION OF PAIN BY INTERNAL SQUEEZING

Pain elicited by internal squeezing shows itself clinically in two ways: by a painful arc, *i.e.* pain elicited in the central part of a range of movement, disappearing when this point is passed, and by the appearance of pain at the extreme of range as two bony surfaces are approximated. Pain evoked by internal squeezing is a most valuable sign; for anatomical considerations can be used to deduce the exact site of the tender structure (see Figs. 30 and 60).

1. *Painful Arc*

The significance of a painful arc is as follows: a tender structure is squeezed where it lies between two bony surfaces. This phenomenon is often encountered during examination of the shoulder-joint; it means that, as the tuberosity passes under the acromion, a tender structure is pinched (see Fig. 32). This, with rare exceptions, incriminates the supraspinatus or infraspinatus or the subdeltoid bursa. A painful arc also occurs on movement at the lumbar and, less often, the thoracic and cervical joints This finding is pathognomonic of hypermobility of part of an intervertebral disc. When the neck or trunk-flexion movement reaches the mid-position, the inclination of the joint surfaces becomes reversed and the loose fragment of disc suddenly moves backwards, jarring the dura mater momentarily. A painful arc occurring at the hip suggests a localized erosion of cartilage; at the knee-joint, an impacted loose body, a transverse crack in a meniscus, or patellar-femoral arthritis. A painful arc on straight-leg raising indicates the existence of a minor protrusion at a low lumbar joint.

2. *Pain at One Extreme of Range*

This may prove a puzzling phenomenon, obscuring the differentiation of inert from contractile structures, since pain is set up when the extreme of range is tested passively. If, for example, the arm is fully elevated, the greater tuberosity of the humerus engages against the glenoid rim and squeezes the supraspinatus tendon. Hence full passive elevation of

the arm may hurt in supraspinatus tendinitis. Similarly, full medial rotation of the arm presses the subscapular tendon against the glenoid rim and full adduction presses the subscapular tendon against the coracoid process When a lesion lies at the teno-periosteal junction of the biceps tendon at the radial tuberosity, this point is pressed against the shaft of the ulna at the extreme of a full passive pronation movement of the forearm. Both the psoas and rectus femoris muscles can be squeezed by full flexion with adduction of the hip The bursa lying in front of the tendo Achillis is squeezed between the tibia and the calcaneus on full passive plantiflexion at the ankle-joint. Finally, the most obvious sign in carpal fracture may be pain on compression of the bone by a passive deviation of the hand towards the painful side

5 THE PASSIVE RANGE OF MOVEMENT IS FULL BUT THERE IS INABILITY TO PERFORM ONE OR MORE MOVEMENTS ACTIVELY

This shows one or more muscles to be out of action either from intrinsic defect such as a cut tendon or a myopathy, or from interference with nervous paths, *e.g* peripheral neuritis, anterior poliomyelitis, cerebral vascular accident or psychogenic disorder In partial palsies or when only one of several muscles that can perform a movement is affected, trial of the resisted movements is needed to disclose the weakness

6 AN EXCESSIVE RANGE OF MOVEMENT EXISTS

This results from capsulo-ligamentous laxity at joints whose stability is not under full muscular control. The structures concerned are the acromio- and sterno-clavicular, the sacro-iliac and sacro-coccygeal joints, the symphysis pubis, the collateral and cruciate ligaments at the knee-joint, the inferior tibio-fibular and the calcaneo-fibular ligaments The liability to subluxation is easily perceived at the superficial joints but not at those placed deeply, *e.g* the sacro-iliac joint. Permanent laxity of any of these ligaments may follow a severe sprain

7. A SNAP OCCURS

This results when a tendon catches against a bony prominence and then slips over it. Such a sequence of events occurs at the shoulder (long head of biceps) and ankle (peroneal tendons); but if a joint is painful and also snaps, it does not necessarily follow that the pain is the result of a frictional tendinitis. At the hip, the greater trochanter may catch against the edge of the gluteus maximus muscle. An osteoma may first declare itself by catching against a tendon. A small semi-membranosus bursa may snap as it jumps from one to the other side of the tendon as the knee is flexed. In trigger-finger a swelling of the digital flexor tendon jams inside the tendon-sheath and holds the finger fixed in flexion until the engagement is passively released with a snap.

8. A CRACK IS HEARD

This is a normal phenomenon, occurring when traction is applied to a joint, especially of the fingers. The investigations of Roston and Haines (1947) showed that traction up to 6 kg. resulted merely in slight separation of the bony surfaces at a man's metacarpo-phalangeal joint. When the traction reached 7 or 8 kg. the bones sprang apart with a loud crack, the distance between them suddenly becoming doubled. Radiography demonstrated that, at that same moment, a bubble of air was formed and was doubtless derived from the synovial fluid present in the joint. It was absorbed again in twenty minutes; before this had happened no amount of tension would make the joint crack again.

9. A CLICK IS PALPABLE

When a loose body lies inside a joint, it may be felt to move from one position to another by both examiner and patient. This is a commonplace at the knee, and often occurs also at the jaw, spinal and elbow joints. Sometimes it may prove possible to manœuvre a loose body about inside the knee-joint digitally. If the knee-joint contains fluid, the patella may be clicked down on to the femur.

Laxity of the ligaments may enable a bone to click as it

moves in relation to its fellow This is common at joints unsupported by muscles, *e.g.* the acromio-clavicular and sacro-iliac, and after capsular over stretching at the shoulder Painless clicking of a costal cartilage occurs

10 CREPITUS IS FELT

The state of the gliding surfaces of a joint is best assessed by palpation of the moving joint. Fine crepitus means slight roughening of the cartilaginous surfaces, coarse crepitus, considerable surface fragmention The intermittent creaking of bone against bone clearly indicates that the articular cartilage has worn wholly through

In the same way palpation reveals the state of gliding surfaces in those tendons that possess a close-fitting sheath. Fine crepitus characterizes acute traumatic roughening of the surfaces coarse crepitus, chronic rheumatoid or tuberculous teno-synovitis

There are two situations where muscular crepitus occurs. When the extensor and abductor pollicis tendons are affected in the lower forearm, crepitus is to be expected locally However it is sometimes felt throughout the muscle-bellies, almost as far up as the elbow (Cyriax, 1941 Thompson, Plewes and Shawn 1951) Again, when the musculo-tendinous junction of the tibialis anterior suffers strain just above the point where the muscle crosses the tibia, a small area of crepitus is usually palpable.

11 A BONY BLOCK LIMITS MOVEMENT

When a joint is felt to come to a dead stop at a point short of its full range of normal movement, a bony block is present. If as is then usual, no pain is elicited on forcing the presence of a neuropathic arthropathy is almost a certainty if forcing is uncomfortable the cause is probably large osteophytic outcrops of bone, myositis ossificans or a malunited fracture close to a joint.

12 NO MOVEMENT IS POSSIBLE

This may result from the intense muscular spasm set up by bacterial arthritis, or from fibrous or bony ankylosis.

Absence of movement at the shoulder- and hip-joints is somewhat masked by scapular and pelvic mobility.

13. NO MOVEMENT HURTS

When there is a full and painless range of passive movement at the joint under examination and no resisted movement hurts either, the pain felt in that region is clearly referred from elsewhere. If this finding is repeated on examination of all the joints whence the pain might spring, the inference is that a tissue outside the sphere of orthopædic medicine is at fault, most often part of the nervous system but sometimes a viscus. In this connexion it should be remembered that in nerve-sheath lesions ordinary neurological examination may disclose no fault, since it estimates only conduction along the nerve. The external surface of nerve-trunks and nerve-roots also suffer painful interference, often insufficient in degree to affect the parenchyma.

Full normal function precludes the presence of a painful lesion. Hence the discovery of tenderness at part of a structure, whose function has already been shown to be normal, is devoid of pathological significance.

OTHER DIAGNOSTIC PROCEDURES

Four other diagnostic procedures may prove useful, but they do not involve testing movement at a joint.

Localization of Lesion in Two Overlapping Tissues. When a muscle overlies another muscle or some other structure, it may be important to decide which of the two is at fault. Tenderness is estimated by applying equal degrees of pressure when the superficial muscle is first relaxed, then taut. If the pain is greater in the latter event, the more superficial of the two tissues is affected. This method can be used to demonstrate whether the fault lies, for example, in the pectoralis major or an intercostal muscle or rib Again, visceral tenderness may be distinguished in this way from tenderness of the actual abdominal wall.

Test for Distant Pain. When a lesion lies in or close to a long bone, pressure applied distantly may cause pain at the site of the trauma. Thus, pressure on the sternum may set

up pain at the site of injury if a rib is broken, or an intercostal muscle torn, or the costo-vertebral joint arthritic.

Diagnostic Traction. If a structure is painfully squeezed symptoms may result which can be abolished for the time being by traction. This is a very valuable sign especially in difficult cases of suspected cervical or thoracic articular derangements For example, pain due to root pressure caused by a cervical disc-lesion may disappear for as long as head suspension or manual traction is maintained Conversely, compression of a joint may increase symptoms, but is a most unreliable sign.

Aspiration. It is often of importance to ascertain whether the fluid in a joint is clear liquid or blood. Aspiration provides an immediate answer and has proved a safe diagnostic method suitable for out patient use. Radiography after air has been injected into a joint occasionally reveals a loose body otherwise invisible.

MISLEADING PHENOMENA

1 *Referred Tenderness* The phenomenon called referred tenderness" by Lewis can be extremely deceptive, and has been considered in Chapter 1

2 *Associated Tenderness* This phenomenon is even more misleading for the tender area is sharply localized and very close to the site of the lesion. The tenderness is undoubtedly connected with the lesion, for both disappear together

Associated tenderness appears to occur at only two sites the radial styloid process as the result of teno-vaginitis of the abductor longus and extensor brevis muscles at the carpus; and the posterior aspect of the lateral humeral epicondyle just above the radio-humeral joint line in the teno-periosteal variety of tennis-elbow No explanation can be offered for this curious phenomenon.

3 *Joint Signs in Root Lesions* In cervical and lumbar disc-protrusion leading to root pressure, a highly misleading phenomenon may be found on examination. In the case of a cervical root, each extreme of movement at the shoulder joint may hurt when tested passively at times one or more of the resisted movements also prove painful. This distracts attention from the neck, focusing it on the shoulder As the

pain in disc-protrusion may be entirely brachial, real confusion easily arises. I have never seen limitation of passive movement result. When pressure is exerted on a lower lumbar nerve-root, testing the hip-joint on the same side may reveal that the extremes of movement are of full range but cause unilateral pain which the patient recognizes as his symptoms. It might well be supposed that the mechanism is the unavoidable transmission of movement to the lumbar joints when the pelvis moves with the hip-joint. This is not so; for the pelvis moves just as much on, say, full rotation of the one as of the other hip-joint. Yet it is only when the joint on the painful side is moved that the symptoms are aggravated.

This phenomenon adds considerably to the diagnostic difficulties in spinal nerve-root pressure. It also serves to explain how patients mistakenly thought to be suffering from arthritis in the shoulder, hip or sacro-iliac joint have been cured by manipulation of the spine.

THE RADIOGRAPH

This is usually most uninformative. If the patient is elderly, osteophyte formation at the spinal, shoulder, sacro-iliac, knee or tarsal joints is often to be seen; nevertheless only the site of the pain and clinical examination reveal whether or not osteo-arthritis is setting up the symptoms. Attempted diagnosis by radiology is an extremely common source of error nowadays, minor abnormalities detected on the x-ray photograph being invoked to explain pains to which they bear, in fact, no relevance. Only when the clinical and radiological diagnoses coincide need the latter be taken as diagnostic.

In fracture work, the radiograph is vital, being very much more informative than any amount of clinical examination; in the practice of orthopædic surgery the radiographic appearances are often diagnostic. In soft tissue lesions, on the other hand, we are dealing with radio-translucent structures and the x-ray photograph is correspondingly uninformative. The radiograph in the type of patient reaching an orthopædic physician, while it excludes certain conditions

and thus narrows the diagnostic possibilities, is seldom of positive assistance. It is apt, however to be extremely misleading and it is at least as important to know when to ignore radiographic appearances as it is to know how to interpret them. The strength to ignore a misleading radiograph comes only from a proper clinical examination

EXAMINATION OF THE NERVOUS AND ARTERIAL SYSTEM

This should never be neglected in cases of obscure pain. The examiner must remember that he is searching, not for the gross signs that characterize advanced neurological disease, but for minor deviations from the normal In nerve-sheath lesions the patient may complain of pins and needles and numbness yet examination reveals that cutaneous sensibility at the area felt to be numb is either normal or so little impaired as to leave the issue in doubt. Alternatively, a small degree of muscular weakness, an area of analgesia rather than of anæsthesia, barely perceptible sluggishness of one tendon reflex, these are the most that can be expected in lesions primarily affecting a nerve-sheath that so often find their way to an orthopædic physician. Obviously, it is before marked signs have appeared that cases of neurological disorder are seen by the practitioner of orthopædic medicine.

When a neurological symptom identifies one cutaneous area, *the whole length of the corresponding nerve must be examined* for the symptoms are felt distally no matter where the nerve-trunk suffers compression For example, ulnar paræsthesiæ may result from pressure on the eighth cervical root, on the lower trunk of the brachial plexus where it crosses the rib, on the ulnar nerve at the back of the elbow or at the wrist. Signs of a relevant somatic disorder must be sought at each of these four levels, and the whole attainable stretch of nerve should be palpated as well Again, paræsthesiæ of median distribution can arise from fifth cervical disc lesions, the thoracic outlet syndrome, and compression in the carpal tunnel search from neck to wrist is required When the paræsthesiæ are felt in, say, every digit of the hand, it is clear that the

lesion lies above the differentiation of the brachial plexus, and a much shorter stretch of nerve need be examined, *i.e.* from the spinal cord to the axilla.

Pulsation in the arteries is often important diagnostically. In intermittent claudication the pulse in the posterior tibial and dorsalis pedis arteries can seldom be felt. In coarctation of the aorta, of which an early sign may be vague pains in the lower limbs, the femoral pulses are absent. In some cases of the thoracic outlet syndrome, and in many normal people, approximation of the scapulæ abolishes the radial pulse.

Electrical Examination in Cases of Nerve-pressure

This is seldom required since careful clinical muscle testing is quite sufficient to assess the state of a muscle when pressure on a motor nerve is suspected. However, electrical examination may be of use in two ways

1. Occasionally, electro-diagnosis proves to be more accurate than clinical testing, showing an abnormality when clinical tests have shown nothing. Usually, in nerve-root and nerve-trunk pressure, the reverse is the case.

2. When the presence of motor disturbance has been ascertained, its type can be determined, *i.e.* whether any degeneration is present or not. Two methods of examination can be used: electrical stimulation and electromyography.

Electrical stimulation is carried out by using square wave impulses of short duration (1 millisec.) and long duration (300 millisecs. or more). If the proper apparatus is available an intensity-duration curve should be plotted; in this way partial denervation is identified with greater accuracy.

The signs of partial denervation are as follows: on electro-stimulation, a sluggish response is elicited by the long duration impulses in some fibres of the muscles and if a curve is plotted it will show the typical double curve of partial denervation, *i.e.* with a kink in the tracing; on electromyography, fibrillation potentials appear when the muscle is at rest, and a reduced pattern on volitional activity is found, sometimes diminished to single motor unit activity.

Of all these signs of denervation, the most reliable seems to be the sluggish response to the long duration impulse. Fibrillation potentials are less common.

Signs of irritation of the nerve, i.e spontaneous motor unit activity firing off at rest, are a rare finding

When the signs of denervation (no sluggish response, normal intensity-duration curve) are absent in spite of the presence of definite muscular weakness detectable on clinical examination the electromyographic findings are a reduced pattern on volitional activity and no fibrillation. This shows that the pressure has not damaged the parenchyma of the nerve, since there are no signs of degeneration, but is sufficient to block conduction.

INTERPRETATION OF MOVEMENTS

Study of the responses to the various diagnostic movements set out above should lead to the appearance of a pattern. Some of these provide an obvious indication, for example, limitation of movement in each direction points to the diffuse capsular contracture of arthritis. Others indicate equally clearly a lesion of muscle, tendon, dura mater ligament or bursa To correlate the site of the patient's pain with the structure shown to contain the lesion is most useful in conditions situated in the distal half of the limbs, for at or below knee and elbow the site of the pain is often close to the lesion. No such help is necessarily afforded at the front or back of the trunk, in the arm, gluteal region or thigh in these areas the site of the pain must be ignored and the pattern emerging from study of the diagnostic movements given full weight. For example, arthritis and bursitis at the shoulder supraspinatus and infraspinatus and subscapular tendinitis, may all result in pain felt only in the middle third of the arm sacro-iliac arthritis may set up pain felt only at the posterior aspect of the thigh capsular pain arising from the hip-joint may be felt only at the knee and pain caused by internal derangement of a thoracic intervertebral joint may be felt only in the chest anteriorly The pattern emerging when the diagnostic movements are collated singles out the structure at fault

If it lies within finger's reach, *palpation* of the tissue shown to contain the lesion follows Palpation is often of importance when the ligaments or tendons at wrist or ankle are involved, to show at what part of their extent the lesion lies. Palpation

may reveal the presence of deformity, swelling, fluid or crepitus. Fluctuation may identify a hæmatoma in a joint or a muscle. Any muscle appears to fluctuate when tested transversely; hence the examiner's finger must lie at different levels along the length of the belly.

Palpation for tenderness of the tissue shown to contain the lesion is always necessary at the distal part of a limb. Bony tenderness may provide the sign suggesting a fracture.

Occasionally no tenderness may be elicited even over the site of the lesion. The examiner must not let himself be dismayed in such a case, though this finding may well make him ponder on the possibility of an erroneous interpretation. Only when the decision has been reached that the lesion is accessible quite superficially can absence of tenderness be regarded as showing the diagnosis to be wrong. By contrast, he must be on his guard against the phenomena of referred and associated tenderness already discussed. Unless the diagnostic movements are given their due importance, the discovery of referred tenderness leads to an erroneous diagnosis.

LOCAL ANÆSTHESIA

When an anatomical localization has been arrived at by deduction from the responses to a series of movements followed by palpation, the possibility of error must be allowed for. Wherever possible, therefore, it is essential to confirm or disprove such diagnoses by the induction of local anæsthesia, at any rate for the first ten years of clinical work of the would-be orthopædic physician. If 5 or 10 c.c. of a 1 : 200 solution of procaine in saline is injected into the point of origin of the pain, the symptoms disappear for the duration of anæsthesia—about 90 minutes. A stronger solution affords no better anæsthesia and the after-pain is more severe (see Chapter XXIII).

In the limbs, if the wrong spot is chosen, the pain, being merely referred thither, fortunately does not disappear. Hence, the criterion in these parts of the body is a good one. Unhappily, the same does not apply to the trunk, especially its posterior aspect. *Pain due to unilateral disc-protrusion in the neck, thorax or lumbar region can sometimes be abolished for the time being by a local anæsthetic injection into the tender*

paraspinal areas This phenomenon remains unexplained and ten years ago served to divert the attention of other physicians as well as myself away from the spinal joints and towards the myofascial structures of the trunk Thus, in the first edition of this book, the contradiction between the results of interpreting the pattern emerging when the diagnostic movements were tested, and the abolition of pain occasionally obtained by inducing local anæsthesia, led me into some confusion As a result, I was led to suppose that both articular and myofascial lesions occurred at the back of the trunk —an opinion that I have now abandoned

Two or three minutes after the infiltration, the patient is requested to repeat whichever movement was found at his examination to be the most painful, and is asked if it still hurts. It is by no means enough to ask the patient as he lies on the couch if his pain has gone In addition, if limitation of some movement existed, its range should be estimated again, *e.g* straight leg raising in sciatic root pressure after epidural infiltration or passive elevation of the arm in subdeltoid bursitis. If the pain has nearly or quite disappeared, the right spot has clearly been chosen If it remains, and the solution has been correctly injected, the diagnosis has been shown to be mistaken , hence the patient must be examined again to see where the error in deduction lies If he says that the pain is only slightly eased, no attention should be paid since many patients like to avoid discomfiting the doctor, especially if students are present.

Local anæsthesia is a most valuable method of confirming localizations arrived at in soft tissue lesions. There is no other criterion of comparable effectiveness By using this method in every suitable case, the physician makes the patient the judge of the correctness of the diagnosis No one else in his department can point his diagnostic errors out to him It is very easy to fall into the habit of assuming that a certain set of symptoms and signs designate some lesion, and it is only when local anæsthesia has conspicuously failed in several consecutive cases that the physician is brought to realize that he has misconceptions on this particular point. In those numerous soft tissue lesions which lie deeply and in which the radiograph cannot be expected to help it is the patient who, with the help of local anæsthesia, assists the physician

to confirm where the lesion lies. Moreover, the physiotherapist, who learns from the patient at his first attendance to her that the pain disappeared for the duration of anæsthesia, knows that the localization is indubitably correct. Thus, in cases requiring friction, she has no hesitation in applying it deeply to the exact spot.

FAILURE TO ARRIVE AT A DIAGNOSIS

Patients in whom a thorough examination on the lines suggested in this chapter fails to disclose the source of the pain fall into five main categories.

1. *Slight Pains*

When the degree of pain is small, the diagnostic movements may not elicit it in the expected way. If such patients are examined again a week or two later, some of them will be found to have recovered spontaneously. Alternatively, others will have got worse, whereupon the lesion becomes clearly definable. This applies particularly to some cases of infectious neuritis or of herpes zoster in which the first symptom may be severe pain unaccompanied by any physical signs. The characteristic signs may not appear for several days; until then no certain diagnosis is possible.

2. *Very Severe Pain*

During the first day or two after an injury of any severity, the pain may be such that the patient cannot state accurately which movements hurt and which do not. Moreover, especially at the shoulder and ankle, every passive and resisted movement may be found to cause pain, no clear pattern emerging at all. When localized tenderness is sought, widespread swelling may obscure it by making all spots appear painful on pressure. When real doubt exists, re-examination at the end of a few days suffices.

In severe nerve-root compression, incipient osteomyelitis or early subacute septic infection of a proximal joint or bursa, clinical examination may prove extremely difficult on account

of an excess of physical signs For example, in severe sciatica the patient may be found lying bent up, the smallest movement of any part of his trunk or lower limbs setting up an intense exacerbation. In the presence of such degrees of pain, the patient cannot allow the range of movement at unaffected joints (e.g the hip) to be tested, nor can he be expected to co-operate when the power in his muscles is to be ascertained. Justifiable fear of pain rightly prevents him from moving

In these cases the history must be given its full weight, gross signs such as muscle wasting or absence of tendon reflexes must be noted and considered in the light of the fact that only a limited number of lesions cause agonizing pain A radiograph may not be obtainable at first because of the difficulties inherent in moving the patient. One must not forget to take such a patient's temperature for a septic process of slow onset may give rise to pain starting in much the same way as disc-lesions or secondary malignant deposits

3 *Lesions Outside the Sphere of the Orthopædic Physician*

The diffuse pains that characterize some diseases of the nervous system and viscera may be difficult to distinguish from the equally diffuse pains so often set up by lesions of the moving parts. Thus the absence of signs of disease of the bones, joints, muscles, etc., of a limb should lead to a neurological examination It must not be forgotten that pain felt in a limb may arise from defects of the circulatory system (e.g angina felt in the upper limb or claudication in the calf), cardiac and arterial examination may thus be required as well. Finally, visceral function must be assessed

4 *Genuinely Difficult Cases*

Most of these are provided by patients with obscure pain in the trunk, especially when the symptoms are felt anteriorly only The distinction between visceral pain and that caused by lesions of the vertebral column may be most difficult to draw Moreover not only may thoracic disc-lesions give rise to thoracic or abdominal pain, but both cervical and lumbar disc-lesions may set up dural pain felt in the trunk

far outside the relevant dermatome. Hence the search must be wide and areas examined from which, in theory, symptoms of such distribution could not arise (see p. 51).

Another source of difficulty is a minor lesion obscured by a psychogenic overlay, the patient putting forward a reasonable story but alleging a number of inconsistent responses on examination. In such a case, it is often advisable to have the patient treated for a week or two by the physiotherapist, even without a definite diagnosis, and to ask the lady almoner for a domestic enquiry. The handling to which the patient becomes accustomed, together with contact with two sensible and dispassionate persons, improves his capacity as a witness when he is next seen. Such treatment is less an evasion of responsibility than preparation for further examination after a clearer picture has developed.

5. *Pain Devoid of Organic Basis*

Patients with assumed or purely psychogenic symptoms constitute a very real problem at physiotherapeutic clinics, to which are properly sent all cases of obscure pain for which an adequate physical explanation seems lacking. For the sake of the practitioner of orthopædic medicine himself, no less than that of the staff of the department, such cases *must* be sorted out. Otherwise he may be led to adopt unwarranted opinions on the efficacy of some form of treatment, since dramatic cure may follow any therapeutic measure, be it an injection, manipulation under anæsthesia, or electrotherapy. Moreover, it is most disheartening to the staff of a department to continue to give treatment endlessly to patients who have no organic lesion.

Detection is seldom difficult. The patient's story may arouse suspicion in so far as a most uncommon sequence of events may be described and the pain found to spread more and more distantly as the narrative continues. The circumstances attending the onset of pain may be curious and tendentiously put forward. A complaint may be made of reference which grossly transgresses the segmental boundaries; but much weight cannot be given to apparent minor inaccuracies. The pain may come and go in a most unlikely manner, and may not obey the generalization that referred pains do not cross the

midline. The degree of disablement may vary from day to day

A great number of active, passive and resisted movements should be performed, the examination beginning at joints as distant as possible from the site of alleged pain Thus, if the upper limb is stated to hurt, the trunk movements may well be tried first. The examiner may find that the painfulness or not of a movement depends on variations in his tone of voice when asking if pain is elicited, or on the care and expectant attitude with which he attempts some passive movement. A long pause between the performance of each diagnostic movement and the response stating whether it hurts or not gives the impression that the patient is trying to think out what best to say

The most striking finding in patients with assumed pain is the fact that no coherent pattern emerges, the patient appearing to answer at random and often contradicting himself Alternatively, every movement at every joint may be stated to cause pain. Again, movements may be said to hurt in areas that they cannot affect. No patient, when asked to perform a series of movements at several joints, can work out quickly in his mind which should and which should not cause pain. When the question of assumed pain has arisen, palpation should begin at some superficial bony point from which (since bone pain does not radiate far) no diffuse pain could spring Diffuse tenderness is often encountered, and has led to the erroneous idea of " diffuse fibrositis ' and " generalized muscular rheumatism."

It is less, however, on the failure of the examiner to make sense of the patient's responses than in the discovery of clear inconsistencies that a diagnosis of psychogenic pain may be made with confidence The response to the same movements may alter when performed with the patient standing and lying or on lying prone and lying supine. The range of movement at a joint may be found much limited in one direction and full in all the others in a manner that does not occur at that joint. Or the patient may be unable to move a joint properly at which the passive range is full and muscle power as tested by resisted movement, normal. If real doubt still exists, the patient may be put on to some indifferent treatment for a fortnight and then examined again. He cannot possibly remember

treatment (*e.g.* analgesics, heat, diffuse massage) or, if a more stimulating effect appears indicated, be put into an exercise class or given faradism. If such indifferent methods alleviate the symptoms, it is obvious that there was nothing much the matter and the doctor is spared a mistaken supposition that a correct diagnosis was made and that accurate treatment was remarkably successful. If no benefit accrues from such "treatment," a second opportunity for examining the patient is afforded at his next attendance. Since precise treatment is adapted to each individual lesion, and has real effect on the tissues treated, it follows that harm is easily done when the wrong type of disorder is thus treated. Consider, for example, the damaging effect of massage to the area about the greater tuberosity of the humerus in a patient thought to have a supraspinatus tendinitis and in fact suffering from subdeltoid bursitis. Or the result of manipulating a supposed tennis-elbow if the true lesion is a traumatic arthritis of, or a loose body displaced within, the elbow-joint. Such errors are by no means unknown and bring precise methods unjustly into disrepute.

It must not be forgotten that effective treatment by massage or manipulation nearly always hurts. Hence due consideration must be given to the individual as well as to his lesion. Will the patient, though the nature of his disorder has been ascertained, be able to stand the requisite treatment? Alternatively, is the patient's frame of mind such that, if anything forcible is done, he will allege that treatment (even though it has not) has caused him lasting harm? A highly neurotic patient with, say, lumbago or a tennis-elbow may be quite unable to allow the performance of the proper manipulations. It is most unwise, if that is the case, to advise such treatment; for the physiotherapist will not be able to give it, and the patient feels that the medical man shows callousness and (after all, correctly) lack of understanding in ordering it. Again, patients anxious to prolong their disability welcome stern measures; for they can then claim that lasting harm has resulted. Even if such patients have some minor lesion on which the exaggerated complaint and excessive disablement are based, it is dangerous to treat that lesion without due regard for the patient's mental attitude. In pain largely psychogenic, removal of its minor organic basis is

often very successful, in wilful exaggeration this endeavour is sure to fail

Accurate physiotherapy will lapse into undeserved disregard if lesions and patients are not selected with adequate care. Patients who cannot tolerate a painful measure, patients who are anxious not to get well and patients in whom an adequate diagnosis has not been arrived at—in all these cases exact treatment should be avoided

Accurate physiotherapy is in its infancy and has so far not been widely accepted Indeed many doctors and physiotherapists have not even heard of its existence. For the sake of the future of orthopædic medicine no less than the proper status of the physiotherapists, every effort must therefore be made to convince the doubtful and the antagonistic This will be achieved as much by the avoidance of prescribing accurate methods in unsuitable cases as by their adequate employment when indicated.

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CHAPTER VII

THE HEAD, NECK AND SCAPULAR AREA

THE chief difficulty when pain in the head, neck or scapular area is under investigation, is the misleading way in which the pain is referred.

REFERRED PAIN

Pain is not referred appreciably from bone; hence in osseous disorders the pain is felt close to the lesion. Capsular pain in the cervical region spreads bilaterally: from the upper two cervical joints to the vertex of the skull, the forehead, temple, and behind the eyes; from the other cervical joints to the root of the neck, at the most as far as the points of the shoulders. The capsule of the cervical joints is by no means insensitive and its contracture provides the source of many elderly patients' headache and neckache. By contrast the capsule of the thoracic and lumbar joints is all but insensitive and is not a source of pain. This is a remarkable difference in clinical behaviour and implies that osteo-arthritis of the cervical spinal joints often causes symptoms, relievable by diminishing the capsular contracture, whereas what is called "osteo-arthritis" of the thoracic and lumbar joints is a painless condition. Capsular contracture and osteophyte formation at the lower spinal joints not only in themselves cause no symptoms but they are actively beneficial, cupping the disc and diminishing movement at the joint and often preventing pain (see p. 422). Thus, osteo-arthritis at the neck is a common disorder, sometimes causing symptoms; osteophyte formation at the lumbo-thoracic spine is clinically silent (see p. 379). This remarkable difference remains unexplained.

In the early stage of postero-lateral disc-displacement, the side of the dura mater is compressed. Then unilateral pain, wholly transgressing the rule of segmental reference, is a commonplace. It has already been stated (see p. 51) that

symptoms arising from the dura mater are apt to be felt in the trunk at an area far removed from the proximal extremity of the dermatome corresponding to the deranged joint. This is particularly so with dural pressure at the neck, when pain in one scapular region, the mid thoracic region posteriorly or even the pectoral area, radiating up to the occiput or even the forehead, may result from pressure at a level whence, in theory, such reference is impossible. Enough patients have even stated that their unilateral cervical pain reaches forwards to behind *both* eyes for me to believe that this is a genuine possibility however inexplicable in the present state of our knowledge of anatomy Occasionally patients have pain extending both upwards to the head and downwards to the hand in such cases the pain may shift from one area to the other during manipulative reduction The same misleading reference of dural pain occurs in disc protrusion at the fourth and fifth lumbar levels, which may give rise to pain radiating to the groin (T 12 and L 1) and/or to the buttock and thigh, whereas the fourth and fifth lumbar dermatomes start just above the knee.

If the cervical displacement increases in size it nearly always moves laterally (see Fig 24) compressing the nerve-root Correct segmental reference down the upper limb then results, sometimes associated with paræsthesiæ in the hand The supervention of root pain is the last stage in cervical disc protrusion, the diagnosis should be made in the stage of thoracic symptoms When a fragment of cervical disc is suddenly displaced centrally backwards bilateral lower cervical or upper thoracic pain results Slow central posterior protrusion, on the other hand, causes no neck symptoms at all pins and needles in hands and feet, or in the lower limbs only, or the painless supervention of a spastic diplegia result.

MISLEADING TENDERNESS

When the lateral aspect of the dura mater is irritated tenderness of the muscles at the site of the pain thus caused is a constant and most misleading phenomenon. This is a genuine, deep, localized muscular tenderness and digital pressure here may even provoke the pain referred to the limb Palpation without previous examination of function

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in such cases has led to the ascription of such pains to a disorder—regarded by me as imaginary (Cyriax, 1948)—called "fibrositis," and various authorities have described myalgic spots and trigger-areas. These exist; but they are the result, not the cause, of the lesion, as reasoned evaluation of the physical signs present will quickly demonstrate.

The suggestion has been made that such tender areas are the result of small areas of fasciculation, secondary to the lower motor neurone lesion. This is not so; for the tender areas are commonly found at the trapezius, rhomboid or spinatus muscles in, for example, seventh cervical root-palsies. muscles belonging to other segments, at which the electromyograph can in any case be employed to prove that fibrillation is absent. No explanation can at present be put forward for this phenomenon, but it is most important that its existence should be recognized; otherwise minor subluxations in the cervical joints will continue to be misdiagnosed as muscle lesions, and the best moment be lost for performing manipulative reduction. Palpation for tenderness has no value in this type of condition; indeed it is often positively harmful, leading the examiner astray in case after case. The physical signs must be sought with care and their significance worked out from the pattern emerging when the appropriate joints, muscles and nerves are examined; this is the clinician's only safeguard against a very common deception.

PARÆSTHESIÆ

Which fingers are involved should always be ascertained. If the inner one and a half or the outer three and a half digits are involved, the nerve-trunks must be examined from the intervertebral foramina as far as the wrist; no indication of the level of the impingement is afforded. If, by contrast, say, all the digits, or the inner three, or the index, middle and long fingers are affected, it is clear that the level of the pressure lies above the final differentiation of the nerves forming the brachial plexus. Hence a complaint of pins and needles in fingers not supplied by *one* peripheral nerve affords a good indication that the pressure is exerted above the level of the shoulder.

EXAMINATION OF THE HEAD AND NECK

HISTORY

In the case of cervical disc-protrusion the history is usually characteristic. The patient suddenly notices pain at the centre or just to one side of the base of the neck, often apparent for the first time on waking He finds the neck stiff sometimes he can scarcely move it at all He may have had transient attacks of this sort before On this occasion, however, the pain goes on and settles in some part of the scapular area, after a few days the neck becomes more mobile. The pain may then begin to radiate down the upper limb, sometimes becoming very severe Pins and needles may come on in the fingers. Rarely, the pain begins distally and in due course spreads up to the elbow and arm, finally some scapular aching is felt In minor subluxations with pressure on the lateral aspect of the dura mater brachial pain is absent, purely scapular pain being felt Rarely the pain is also or only pectoral or axillary Its relation to coughing, breathing exertion and cervico-thoracic movement then helps to distinguish it from conditions like diaphragmatic pleurisy, angina, phthisis and infectious neuritis It must not be forgotten that coughing sometimes hurts in cervical disc-lesions, and a deep breath nearly always hurts the chest in thoracic disc lesions even swallowing may be uncomfortable when part of a cervical disc is displaced

In elderly patients headache or bilateral occipito-cervical pain often results from an affection of the upper cervical joints (intervertebral and lateral), usually osteo-arthritis, sometimes osteitis deformans, there is a constant ache aggravated by movement of the neck. Though the pain is not severe, the ordinary analgesic drugs have little or no effect on it. Unilateral cervical pain in the elderly is usually caused by osteo-arthritis complicated by fragmentation of cartilage with displacement resulting in a minor degree of lateral dural pressure. In younger patients, spondylitis deformans gives rise, of course, to pain and stiffness at the neck radiating to the head as a rule the history of lumbo-sacral pain finally reaching the neck gives the clue, but the lumbo-thoracic condition may evolve painlessly and difficulty in turning the neck be noticed as the first symptom.

Migraine

The history is particularly valuable in distinguishing migraine In clear cases, a long history—often starting in adolescence—of sudden onset of unilateral throbbing headache is characteristic It may change sides; it spreads to the rest of the neck; photophobia, visual hallucinations, tunnel-vision and prostration occur; vomiting brings relief. Sometimes, however, the headache is bilateral and not accompanied by typical symptoms; then the diagnostic feature is recurrent severe headache of unprovoked onset, without stiffness of the neck, followed by sudden complete subsidence of all pain until the next attack. "Occipital neuralgia" also behaves in this way. In addition, I cannot help believing that such a thing as chronic migraine exists; for middle-aged patients with a history of life-long attacks of migraine may state that their acute attacks have ceased but that they now have constant headache This is doubtless a migrainous equivalent and, though it is unaffected by ordinary analgesic drugs, often responds to dihydroergotamine (10 drops t d s.). Such patients are often thought to be exaggerating their symptoms or to suffer from hyperpiesic headache or temporal arteritis.

An attack of migraine can sometimes be instantly aborted by strong traction on the neck. Half a minute's traction in some cases is regularly successful, in others not. The mechanism is obscure (it may be connected with the stretching of the carotid artery) and the phenomenon would clearly repay further study, since it affords one criterion whereby two different types of migraine can be simply differentiated.

For many years, I supposed, on what appeared to me logical grounds, that manipulation of the neck could have no preventive effect on migraine, but only on those headaches mistaken for migraine. But a minority of patients have reported to me, some years after the reduction by manipulation of a cervical disc, that since that time attacks of obvious migraine have ceased. One patient, most justifiably regarded as suffering from migraine by three neurological consultants, had for years been having attacks at about monthly intervals severe enough to require morphia. Manipulation stopped these attacks for eighteen months; there was then a slight

return, and another manipulation has now kept her comfortable for a further two years The fact that manipulation of the neck sometimes causes attacks of migraine to cease in middle aged patients but not in the young makes me wonder if an occasional precipitating factor in periodic headache is that described by A. Kovass (1955) His careful radiological studies show that the superior articular process of a cervical vertebra can develop an osteophyte that presses on the vertebral artery and the sympathetic fibres running with it Were pressure at this point exerted by a small displaced fragment of exfoliated articular cartilage within the lateral joint, manipulative reduction could prove lastingly successful

INSPECTION OF THE NECK

The neck may be held in an asymmetrical posture, if so note should be taken whether the deformity is a pure lateral list or contains an element of rotation as well, if there is pain, the deviation may be towards or away from the painful side.

Congenital Torticollis

Painless congenital contracture of one sterno-mastoid muscle results in the neck being fixed in side-flexion towards the affected side and rotation away from it. In babies there may be a swelling on the muscle, but usually not.

Neglected cases are seen in which the contracture has resulted in permanent postural deformity of the neck and facial asymmetry Treatment should have been instituted by stretching out the sterno-mastoid muscle and subsequent maintenance of the over-corrected position as soon as the baby was seen. If this was not done, tenotomy of the sternal and clavicular heads of the muscle may be required in adolescence, followed by vigorous after-treatment

Acute Torticollis in Children

This is an interesting condition, as yet little understood Children between the ages of five and ten usually after a sore throat, suddenly develop a stiff neck, with little or no pain Inspection shows the neck to be held in flexion towards

one side and rotation in the opposite direction. The resisted neck movements are not weak but may be slightly painful. There may be glands in the neck, with more tenderness perhaps on the contracted side, suggesting recent tonsillitis. The radiograph reveals the postural deformity of course, but no other lesion.

I do not know what is the cause of this condition, but I feel sure that it is not caused by a cervical intervertebral disc-lesion, or by acute myositis or by anterior poliomyelitis. The condition resolves spontaneously in about a fortnight, and probably results from a swollen gland lying under and irritating the sterno-mastoid muscle. This seems to be a minor form of the well-known fixation of the neck from glandular enlargement that characterizes the anginal variety of glandular fever.

At all events, cure appears to be hastened by short-wave diathermy to the mid-cervical area; manipulation and exercises are useless and unkind. Beeson (1942) described what appeared to be an epidemic of infectious torticollis amongst a group of young adults; this condition has not been reported again since, but may be a connected disorder.

It must not be forgotten that in children occasional cases of afebrile otitis media are encountered. The presenting symptom may then be merely pain in the neck, and the only sign for the first week or two, torticollis The neck is held immobile by muscle spasm and the slightest attempt at any passive movement provokes pain and is resented and strongly resisted This is a greater degree of limitation of movement than occurs in the transient torticollis described above, and such signs, in the absence of x-ray evidence of disease of the cervical spine, should lead to aural examination

Acute Torticollis in Adults and Adolescents

Disc-lesions causing acute torticollis scarcely occur before the age of twelve but begin to be quite common at about fifteen. Whereas disc-lesions at thoracic and lumbar levels causing root-pain are also not infrequent in adolescence, cervical disc-lesions, though a common cause of scapular aching, appear not to cause root-pain before the age of thirty. In the acute torticollis of adults and adolescents rotation

deformity is absent and the cause is subluxation of part of a cervical intervertebral disc. There may or may not be a lateral shift, but the neck is held stiffly and can hardly be moved at all for the first day or two

Spasmodic Torticollis

The diagnosis is made on inspection. The patient is seen suddenly to twist his head always in the same direction, by an apparently irresistible active movement. The complaint is of social inconvenience, not pain The movement can be prevented by the patient's or the examiner's manual pressure, which can also be used to overcome the muscles and rotate the head back into the neutral position again The muscles give way in the manner suggesting neurological hypertonus, there is strong resistance at first, but when the muscles begin to give, all resistance ceases immediately Apart from the repeated movement, nothing abnormal is found when the neck is examined. Spasmodic torticollis had always been regarded as a tic, hysterically produced Critchley (1938), however, distinguishes four types (1) purely psychogenic, (2) following epidemic encephalitis (often transitory), (3) forming part of a more wide-spread extrapyramidal lesion and (4) a gradually progressive tonic-clonic spasm not confined to the neck muscles By performing an intra cerebral injection, Russell (1938) had produced spasmodic torticollis accidentally in a monkey Post mortem examination showed a subthalamic infarct. In organic disease, associated movements may relax the spasm. For example, the patient's head may be fixed in extreme rotation from which position he cannot move it except by bringing his hand to his mouth, whereupon the head automatically turns forwards

In early mild cases, it is worth while trying to teach a co-operative patient to move the head in the opposite direction at the moment when he feels the involuntary movement about to begin this may keep the head still. Other physiotherapy is quite useless, hypnotism has an occasional success If the symptoms warrant, assessment of which muscles are causing the movement should be attempted denervation by means of root-section and/or division of the spinal accessory nerve may then bring about marked improvement.

Hysterical Torticollis

These cases are easy to detect; for the patient contracts his vertebro-scapular muscles, thus keeping the scapula hunched as well as flexing the neck towards that side. Elevation of the scapula can play no part in an organic lesion resulting in the head being held fixed in side-flexion.

These cases often show little response even to adequate psychotherapy; the physiotherapist seldom succeeds in persuading the patient to abandon this posture.

Cervical Kyphosis

This finding calls for immediate radiological examination, since it suggests wedging of a cervical vertebral body. Fracture is not uncommon, and may set up such slight symptoms that the patient's recollections consist merely of a fall on the head years before, followed by some days' stiffness of the neck. Alternatively, secondary neoplasm or tuberculous caries may be present.

It should be remembered that the spinous processes of the third, fourth and fifth cervical vertebræ are much shorter than those above and below; hence palpation is apt to reveal a lordosis even in cases of marked wedging of a vertebral body. Thus the presence of a kyphosis is suggestive, but its absence has no negative significance.

Occasionally cervical kyphosis may result—as at the lumbar spine—from central posterior herniation of a part of a lower cervical intervertebral disc. Such cases are characterized by the absence of evidence of disease of bone on the radiograph, in spite of manifest clinical deformity of recent onset. Occasionally the patient can hardly move his chin from his chest at all. In such cases, manipulative reduction must be undertaken very gradually and with great care, for fear of the protrusion being forced against the spinal cord.

Inspection of the Scapular Area

The level at which the scapulæ lie is noted; a downward and outward displacement suggests trapezial weakness secondary to accidental division of the spinal accessory nerve

during an operation for glands in the neck. A localized neuritis of this nerve is a rarity Prominence of the vertebral border of one scapula suggests a long thoracic neuritis with paralysis of one serratus anterior muscle. If both scapulæ are affected thus, and both muscles found weak, myopathy is present. If a thoracic kyphosis is present in children and thin adults the lower angles of the scapulæ stand out prominently This results from a flat bone lying against a curved surface. Being held applied to the thorax superiorly by muscular tension, it is the lower part of the bone that projects (Such patients should be treated for the causative kyphosis, exercises to strengthen the thoraco-scapular muscles naturally have no good effect.) Occasionally inspection of the scapula reveals isolated wasting of the infraspinatus muscle, rupture, myopathy traumatic or infectious suprascapular neuritis or severe arthritis of the shoulder then have to be considered The contour of the arm is also noted (see Chapter VIII)

Fixation of one scapula at a higher level than the other characterizes congenital elevation of the scapula (Sprengel's shoulder) The levator scapulæ muscle is replaced by abnormal bone—the suprascapula.

Enlargement of the clavicle provides an occasional manifestation of osteitis deformans subluxation at the sterno-clavicular joint gives rise to false appearance of enlargement by making the bone prominent. Congenital absence of the clavicle, nearly always bilateral, and with such undue mobility of the scapulæ that the shoulders can be made to meet in front of the sternum, characterizes cleido-cranial dysostosis.

EXAMINATION OF NECK MOVEMENTS

The active, resisted and passive movements of the neck are examined The patient sits on a couch, this prevents his moving his trunk as well when asked to move his neck, and the examiner is well placed for resisting the scapular movements, when they come to be tested Neck movements are flexion, extension, flexion to each side, rotation to each side. Their range is noted and whether or not each sets up pain The painfulness of the resisted movements is assessed weakness is a rarity The passive movements show whether or not a full range at the cervical joints exists and provides

useful data for correlation with the findings on active movement. If the passive movements are tested with the patient lying supine, it must be remembered that a much greater range exists in this position than when the patient sits up. Hence, apparent minor discrepancies in the range of movement have no significance and provide no evidence that a psychogenic disorder is present.



FIG 22—Resisted side-flexion of neck The examiner's one hand steadies the patient's shoulder, while the other resists the movement of the head

Since testing the resisted movements (see Fig. 22) so seldom causes pain (except in fracture of the first rib, anginal glandular fever or acute adult torticollis), it becomes clear that at the neck articular lesions predominate and muscle-lesions hardly occur. The chief virtue in examination of the muscles against resistance is the information afforded in cases of suspected psychogenic disorder.

Gross wasting of both trapezius muscles and of the erector muscles of the neck occurs in myopathy. The patient has difficulty in holding the head up for long, and the muscle wasting on each side results in great prominence of the spinous processes of the cervical vertebræ. On account of the flexion deformity and muscle wasting, these signs may be mistaken for arthritis at the cervical joints: an error that the

radiograph, if the patient is middle-aged, appears to confirm Myasthenia gravis occasionally first shows itself as an inability to hold the head up for long e.g at the theatre. In paralysis agitans, pain and limitation of voluntary neck movements are sometimes the presenting symptom.

Fracture of the First Rib

A rare cause of scapular pain—usually lasting not more than a week or two—is fracture of the first rib This may be of the stress variety and remain symptomless throughout, being discovered only by a chance x ray examination for some other condition Others follow an accident and are difficult to tell clinically from the internal derangement of a mid-cervical joint that occurs during similar injuries.

In either case the pain is scapular, with little or no reference to the arm. Side-flexion of the neck towards the painless side naturally hurts because the scalenus medius, which usually lies just lateral to the line of the fracture, then pulls on the outer fragment. Resisted side-flexion towards the painful side also hurts, however This combination identifying the lesion as connected with the side-flexor muscles should lead to radiological examination Confirmatory clinical signs in severe cases are scapular pain on coughing or taking a deep breath and limitation of voluntary abduction of the arm above the horizontal.

If the symptoms warrant, the arm should be rested in a sling and passive then active arm movements begun Otherwise, no treatment is required.

EXAMINATION OF SCAPULAR MOVEMENTS

The patient is asked to shrug his shoulders, this demonstrates whether or not the scapula possesses a normal mobility in relation to the thorax. Crepitus on this movement is noted. Pulmonary neoplasm, contracture of the costo-coracoid fascia, and secondary malignant deposits in the scapula limit passive mobility In advanced spondylitis deformans the acromio-clavicular joint may suffer ankylosis, scapular movement is then grossly limited and the arm cannot be raised beyond the horizontal. If paræsthesiæ appear in the hands after the scapulæ have been kept elevated

for a minute or so, the thoracic outlet syndrome is present (see p. 177).

The resisted scapular movements are tested next (see Fig. 23): (1) elevation (trapezius and levator scapulæ muscles),

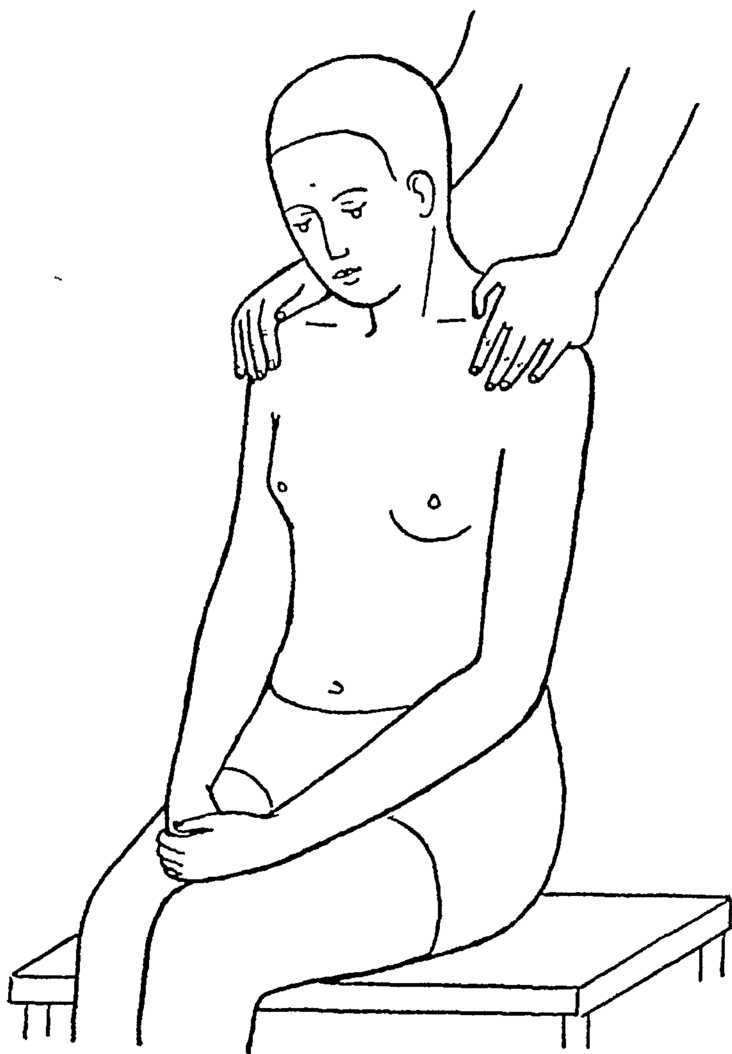


Fig. 23.—Resisted elevation of scapulæ The examiner's hands press downwards as the patient shrugs his shoulders

(2) forward movement (pectoralis minor and serratus anterior), (3) backward movement (rhomboids) and pressing against a wall with the arms held forward horizontally (serratus anterior). It must be remembered that the active scapular movements also affect the joints at each end of the clavicle



PLATE 1

Gonococcal arthritis of the hip Twenty years previously this patient, now aged 66, had spent six months in bed with gonococcal arthritis at his hip The contrast is striking between the x ray appearances and the fact that a full and painless range of movement at the joint was present. The muscles were considerably wasted.

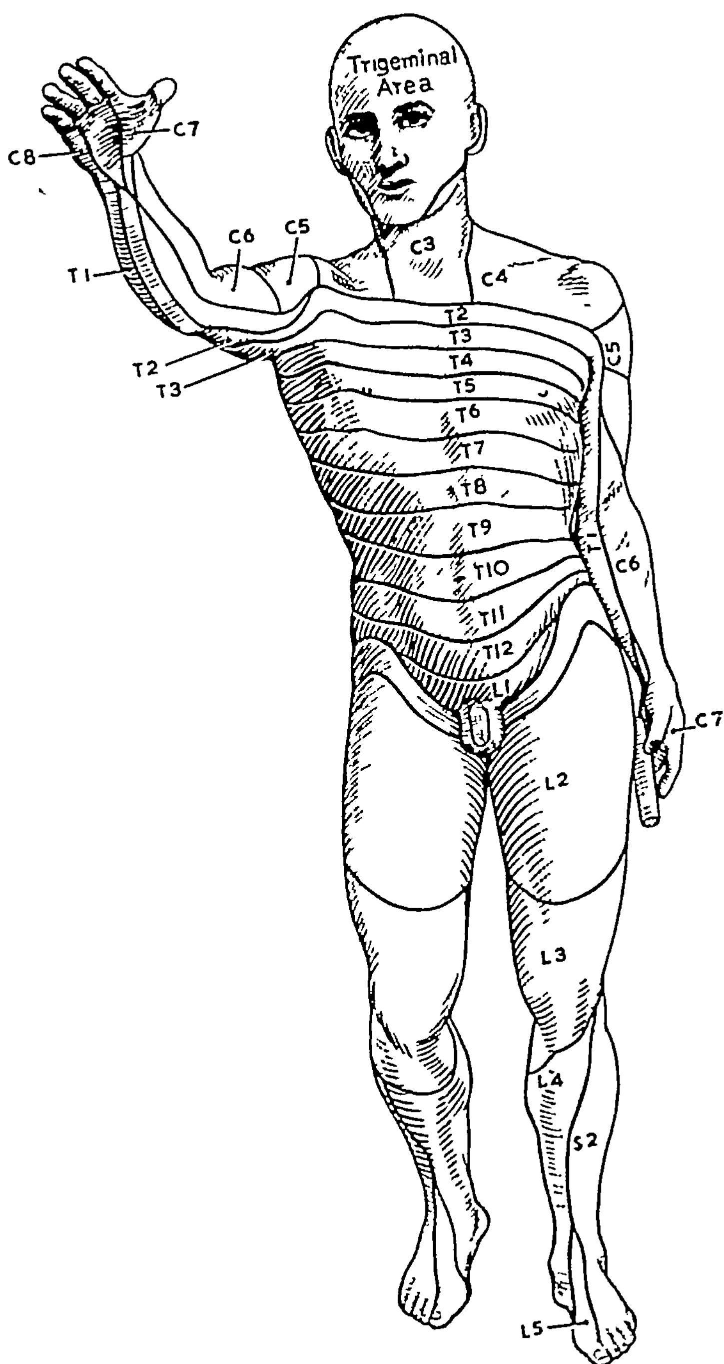


PLATE 2

The dermatomes Anterior view of the embryological segments of the skin (after Déjerine) Note how the circular arrangement at the has suffered deformation at the lower cervical and lower lumbar where the dermatomes have been drawn out into the limbs

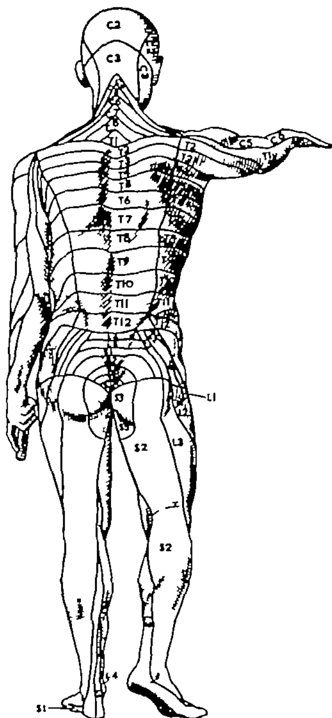


PLATE 3

The dermatomes. Posterior view of the embryological segmentation of the skin (after Déjerine) These two diagrams give an adequate impression of the general arrangement, but do not allow for the considerable overlap. Only the central portion of each dermatome is outlined.



PLATE 4

Sixth cervical disc-lesion. Lateral view of cervical spine showing marked narrowing and tilt at the sixth cervical joint. This contrasts with the normal spaces above and below. The patient had a seventh-root palsy.



PLATE 5

Cervical spine Radiograph taken before traction. Compare with Plate 6.

PLATE 8

Cervical myelogram Contrast radiograph of a sixth cervical disc-lesion, taken four months after the onset of the brachial symptoms, when the root-pain had almost ceased Note the unilateral arrest of contrast medium at the sixth level

Although the neck, thorax and scapulæ have now been tested it is quite unsafe to stop the examination at this point, even if the patient has purely scapular or cervical pain The upper limb must be examined next for evidence of a neurological lesion. Unless muscular weakness is carefully sought, a lesion of a nerve-root or a nerve-trunk may escape detection Moreover, pulmonary sulcus tumour or neoplasm in the cervical spine cannot be excluded in the earliest stage merely by relying on the radiograph, whereas examination of the forearm and hand reveals muscle weakness. Finally evidence of an upper motor neurone lesion should be sought by examination of the legs, for a central posterior protrusion at a cervical or thoracic joint may press directly on the spinal cord

If the active scapular movements hurt but the resisted do not, without limitation of range, two more conditions are brought to mind—namely a first or second thoracic root lesion or strain of the costo-coracoid fascia

Just as straight leg raising stretches the sciatic nerve-roots so do both scapular elevation and approximation stretch the upper two thoracic roots Hence, when the mobility of either root is impaired, the scapular movements set up pain felt at the lower scapular area and the inner aspect of the arm

When these same scapular movements bring on pain felt antero-laterally at the base of the neck, strain of the *costo-coracoid fascia* must be considered The pain is purely local and felt behind the mid-clavicle, and is apt to be evoked by side-flexion of the neck away from the painful side resisted side-flexion towards the painful side active and passive, but not resisted, elevation of the scapula, several of the resisted movements of the shoulder Such a pattern suggests fracture of the first rib or a psychogenic disorder but is also consistent with a lesion affecting both the first rib and the scapula *i.e* the fascia connecting the coracoid process to the first rib

The tenderness may lie just below the junction of the outer with the middle third of the clavicle and deep massage to this spot is then curative in three to six sessions if the contracture occurs elsewhere in the fascia or results from dense scarring at the apex of the lung the disorder is intractable.

Summary

Full examination for scapular pain of somatic origin thus consists of:

(1) Inspection.
(2) Testing the joints of the neck and thorax by active and passive movements.
(3) Testing the muscles of the neck, scapula and arm by resisted movements.
(4) Neurological examination of the upper limb for lower motor neurone lesion.
(5) Neurological examination of the lower limb for upper motor neurone lesion.

INTERPRETATION OF NECK MOVEMENTS

If limitation of movement is present equally in all directions in an elderly patient, marked osteo-arthritis is present. When all the neck movements are grossly limited in a young patient, and the radiograph reveals no abnormality, spondylitis deformans is present, since the other causes, *e.g.* caries, show clearly on the x-ray picture. If all the movements at the cervical spinal joints are limited in the disproportionate pattern and the onset is acute, sudden intra-articular displacement has occurred; if the range of movement is full, but the pain unilateral and provoked by the active and passive but not resisted neck movements, then too a disc-lesion is present. Other characteristic signs of a disc-lesion exist: they are: (1) Limitation of active and passive movement in some directions, full range in other directions. This also implies disproportionate limitation of movement—an indication of internal derangement of a joint. (2) A painful arc on neck movements; this may be felt on flexion, as at the lumbar spine, but also occasionally on rotation or side-flexion.

Limitation of movement in all directions associated with pain elicited by resisted neck movements occurs only in post-immobilizational stiffness, *e.g.* after fracture of the base of the skull. In such cases diffuse adhesions have formed about the base of the occiput owing to prolonged rest in bed after the concussion. Limitation of active but not passive movement at the neck occurs in paralysis agitans.

CERVICAL ARTHRITIS

Osteo-arthritis is common and usually involves all the cervical spinal joints, perhaps the thoraco-lumbar joints as well. The osteo-arthritis that results from past trauma affects one or two adjacent joints and is seldom severe enough to set up much aching Spondylitis deformans may result in almost complete ankylosis stiffness of the joints in this disorder precedes local radiographic evidence of the disease by many years. If lumbo-thoracic involvement has progressed painlessly—as may happen—the diagnosis may remain obscure unless the whole back is inspected The radiographic appearance, not of the cervical spine, but of the sacro-iliac joints, is diagnostic.

Wedge-fracture of a cervical vertebral body, left untreated, usually becomes symptomless after a week or two It is often first discovered years later when fragmentation of the disc or localized or generalized osteo-arthritis of the cervical joints draws attention to the neck. Radiographic signs of osteophyte formation at the cervical spinal joints is compatible with full painless function, hence the diagnosis that a patient's symptoms result from osteo-arthritis is purely clinical and cannot even be corroborated—though it can be disproved—by radiography

There is one disorder that may give rise to combined articular and muscular pain post-concussional symptoms The patient lies in bed for some months after a head injury, often fracture of the skull During this time it is not feasible to give neck exercises Hence healing in the absence of adequate movement occurs both at the damaged upper cervical joints and at the muscular attachments at the occiput. Such patients are often suspected of various degrees of psychoneurotic pain at the base of the skull yet it is massage to the muscle origin together with manipulation of the joints —often, alas, carried out by an unqualified manipulator—that brings lasting relief in the end

OSTEO-ARTHRITIS OF A LATERAL ARTICULATION

Although often symptomless, leading merely to painless limitation of movement, advanced osteo-arthritis of one lateral articulation can cause pain

The symptoms are merely unilateral aching at the *upper* neck in an elderly patient, going on more or less unchanged for years. The pain is felt at the mid-neck or even under the occiput, and does not radiate to the base of the neck as happens with a cervical disc-lesion The position of the pain combined with its mild and unvarying course provides a strong diagnostic pointer.

Clinical examination confirms this probability when it is found that all six active movements of the neck are somewhat limited and give rise to the unilateral pain. This pattern means that arthritis is present; for were the pain caused by a disc-lesion some of the neck movements would be painful at extremes, others painless If then, arthritis exists but the *symptoms are unilateral, the intervertebral joint is* exculpated and osteo-arthritis of the lateral articulation remains the only possibility.

The radiograph reveals marked unilateral osteo-arthritis, most often at the third and/or fourth cervical levels.

Treatment, as elsewhere, consists in stretching the joint out by slow strong pressure. This often abolishes the constant ache together with the pain felt at some of the extremes of range; but it seldom affects that brought on by side-flexion towards the painful side since this is the result, not of capsular contracture, but of bone pressing against bone.

SECONDARY MALIGNANT DISEASE AND FRACTURE

Secondary deposits in the upper cervical vertebral bodies are a rarity. When the first, second or third cervical vertebræ is eroded, the characteristic nerve-root weakness found on examination of the upper limbs is absent The patient merely states that stiffness and central neckache of increasing severity have come on rapidly during the last month or two.

Examination shows gross limitation of movement in each direction, especially extension and rotation. Such great limitation, were it caused by osteo-arthritis, would have come on slowly in the course of many years, in fact, the disorder dates back only several weeks If the neck is very gently forced, movement is found to be restricted by pain and muscular spasm, not by the bone-to-bone feeling present at the limit of an osteo-arthritic cervical joint. In due

course, radiography demonstrates the erosion A chordoma grows very slowly and may be radiologically invisible for several years Biopsy may be required eventually to confirm the diagnosis I have known such patients manipulated by laymen without lasting harm. The feel of the muscle spasm when the neck is moved passively is characteristic.

Fracture of a vertebral body leads to identical limitation of movement in each direction, especially extension The history of trauma and the fact that the patient is usually not elderly show that a lesion of bone exists caused by injury, not neoplasm. Radiography is confirmative

SUBLUXATION OF PART OF A CERVICAL INTER VERTEBRAL DISC

N.B From the clinical point of view the cervical spine includes the upper two thoracic vertebræ, which are examined with the other segments forming the upper limb Hence the two uppermost thoracic joints are tested with the neck, the thoracic type of examination (see p 810) becoming relevant from the third to the twelfth thoracic level

Just as fragmentation of a low lumbar intervertebral disc may result in backache only as the result of pressure exerted indirectly on the dura mater so may a lesion of a cervical intervertebral disc set up pain felt in the neck and scapular area only A diagnosis of a cervical disc-lesion would be made with caution in children the earliest age at which I have encountered a case is eleven years and the disorder is most uncommon before the age of fifteen.

The principles underlying the examination are two First, testing the neck movements shows a unilateral articular lesion to be present. Some of the active and passive, but none of the resisted, movements elicit the unilateral dural pain, which is felt at the base of the neck or in the scapular area. Secondly, examination of the upper limb may afford information on the level of the protrusion If not, the exact joint at fault remains indeterminable.

Articular Signs The articular signs are the same whatever the level of the lesion Hence examination of the joints of the neck establishes that a subluxation has occurred, the

search for evidence of root-pressure may later demonstrate at which level the subluxation lies. At the onset, the neck movements may be extremely limited, but more so in one direction than another. Any attempt at active, resisted or passive movement produces severe pain felt at one side, less often the centre, of the base of the neck or of the upper posterior thorax. In the untreated case, the range of movement increases so that after a week or so full range is restored in some directions, slight limitation remaining in others. At this stage, some but not other of the neck movements reproduce the scapular pain. If the condition gets worse, pain

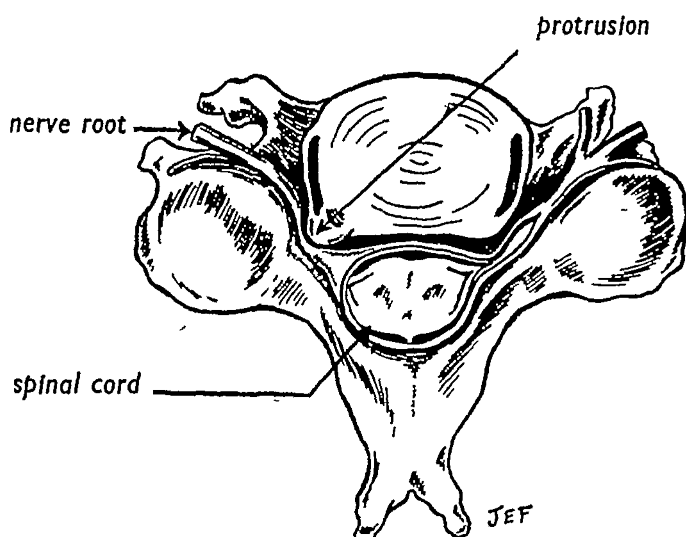


FIG 24.—Protrusion of disc substance at a lower cervical joint causing root-pressure

spreads down the upper limb and may reach the fingers, which *may* become the site of pins and needles, and one or two finger-tips sometimes go a little numb. At this stage the examiner must not expect any of the neck movements to reproduce the pain in the upper limb; they do so only occasionally, but the scapular pain is still reproduced at the extreme of two or more movements of the neck.

Root Signs. A cervical disc-herniation results in pressure on one root only Hence paresis of one root is confirmatory evidence of a disc-lesion By contrast, if the pattern of muscular weakness does not correspond to that set out below, it is most improbable that internal derangement of a cervical joint is the cause.

In root pressure the symptoms are threefold and the signs twofold, the symptoms are of (1) internal derangement at the joint, i.e lateral dural pressure resulting in scapular pain, (2) compression of the nerve-root, i.e brachial pain, and (3) interference with the parenchyma of the nerve-root, i.e weakness However the signs relate only to the first and third of these factors Since there exists no separate test (in contrast to the sheath of the lower three lumbar nerve roots) for the sheath of any cervical nerve-root, the signs are (a) articular, (b) parenchymatous The examiner must not await the appearance of pins and needles, numbness, muscle weakness and alteration in the tendon reflexes before making the diagnosis, otherwise a large number of cases will be missed during the early stage when treatment is at its most effective.

PRESSURE ON INDIVIDUAL ROOTS

The first cervical root emerges between the occiput and the atlas, and the eighth cervical root between the seventh cervical and the first thoracic vertebra. The first inter vertebral disc lies between the second and third cervical vertebræ. It follows that any cervical intervertebral disc, when it protrudes, compresses the root one greater in number : e.g the disc at the sixth joint affects the seventh root. There is a curious anatomical peculiarity at the first and second cervical levels The uppermost two cervical nerves emerge in front of the articular masses, whereas at the whole of the rest of the spine each nerve emerges posteriorly

First and Second Cervical Roots

False Reference Cases are not infrequently encountered of pain in the neck, spreading to the vertex of the skull (C 1) or to one temple, the forehead and behind one or both eyes (C 2) Examination shows the pain to originate in the joints of the neck and manipulation abolishes it. In young patients there is no question yet of osteo-arthritis leading to bilateral capsular pain felt in the head moreover the pain is unilateral. The cause cannot be a disc-lesion at the upper two joints, since they do not contain a disc. I feel sure that pain in the head associated with a cervical disc lesion is only another

example of non-segmental reference from the dura mater; it has nothing to do with the first and second cervical nerve-roots.

Root-pressure. Unilateral pain felt at the upper neck accompanied by *tingling* in the occipito-parietal region on the same side is a rare complaint in elderly patients; this appears to be a true localizing sign. Examination of movements gives the articular pattern accompanied by marked limitation of movement in every direction. Rotation may be reduced to 10° range. Gross osteo-arthritis at one side of the atlanto-axial joint is presumably responsible, with an osteophyte engaging against the second cervical root.

Third Cervical Root

This is rarely affected. Cervical disc-lesions at the second level are identified by the symptoms (giving the level) and neck-signs, showing a cervical joint to be affected.

Possible symptoms are: in addition to the unilateral pain in the neck, pins and needles felt at the pinna, the posterior part of the cheek, the temporal area and the whole lateral aspect of the neck, with a forward projection under the body of the mandible. Clinically I have never detected muscular weakness, but electromyography (kindly carried out for me by our former Chief Assistant, Dr. Woodhouse) has shown unilateral motor-unit activity indicative of partial denervation in the sterno-hyoid, sterno-thyroid and the mid-fibres of the trapezius muscle. Occasionally unilateral analgesia of the skin of the whole of the back of the neck is detected. Rarely, paræsthesiæ in one cheek are the only symptom; naturally this draws immediate attention to the trigeminal nerve. When repeated expert neurological examination reveals no lesion of this nerve, and time shows that the trouble is not progressive, the patient is usually regarded as imaginative or, at best, as suffering from an undiagnosable disorder.

A clear example of a third cervical root-pain with unusually extensive symptoms is described below:

A woman of 45 years complained that, for the past six months, she had had repeated bouts of pain brought on by turning her head sharply to the right. During an

attack the neck was fixed for some seconds in side-flexion to the right by severe pain felt at the occiput and the left side of the neck. Simultaneously the tongue and the back of her palate went numb remaining so for about a minute. This was followed by pins and needles occupying the back of the head and the whole left side of the neck and the upper inner scapular area. These paraesthesiae lasted twenty minutes, whereupon she was quite all right again until an unguarded rotation movement brought on the next attack.

Fourth Cervical Root

These cases are rare. The pain spreads outwards from the mid neck and is concentrated at the shoulder This distribution is slightly different from that caused by pressure on the side of the dura mater at any cervical level for in the latter event scapular pain spreads evenly down the arm, and does not end abruptly at the deltoid area. Pins and needles are absent I have not been able to detect any muscle weakness in cases of protrusion at this level, but cutaneous analgesia just above the clavicle extending to the front of the shoulder is met with

Fifth Cervical Root

The pain reaches from the scapular area to the front of the arm and forearm as far as the radial side of the hand it does not extend to the tip of the thumb, and pins and needles are in my experience, absent *The weak muscles are* the two spinati, the deltoid and the biceps. The biceps jerk may be sluggish or absent, the brachio-radialis jerk sluggish, absent or inverted

Differential Diagnosis The most difficult finding leading to frequent errors especially in elderly patients, is a combination of osteo-arthritis of the neck (leading to pain—felt bilaterally however—at the extremes of range) and some other lesion (*e.g* supraspinatus tendinitis or osteo-arthritis of the shoulder) giving rise to pain felt in the arm This may be mistaken for osteo-arthritis with fragmentation and

the latter case the neck movements hurt in one scapular area only and examination of the upper limb reveals no alternative cause for the brachial pain. Careful examination is required in cases of this type, which are most difficult to sort out.

The conditions to be kept in mind are enumerated below:

1. Traction palsy of the fifth cervical root
2. Palsy of the axillary nerve after dislocation of the humerus at the shoulder.
3. Infectious neuritis of the long thoracic or suprascapular nerve.
4. Traumatic palsy of the suprascapular nerve.
5. Herpes zoster
6. Myopathy affecting the deltoid and spinatus muscles, complicated by capsular pain (due to disuse contracture) emanating from the shoulder-joint
7. Partial rupture of the supraspinatus tendon
8. Rupture of the infraspinatus muscle.
9. Secondary malignant deposits at the scapula.
10. Diaphragmatic pleurisy.

Sixth Cervical Root

The pain spreads down the front of the arm and forearm to the radial side of the hand, and pins and needles felt in the thumb and index finger are a conspicuous feature; cutaneous analgesia is often detectable at the tips of these digits. *The weak muscles are:* biceps, supinator brevis and the wrist extensors. Wasting of the brachio-radialis muscle may be visible. The biceps-jerk is sluggish or absent, sometimes as an isolated finding.

Differential Diagnosis. At this level, the difficulty lies in the fact that the muscular weakness is often slight. Electromyography may prove of assistance, but paresis detectable clinically often appears before the electrical testing reveals any abnormality. The conditions that give rise to similar symptoms are:

1. Pressure on the median nerve in the carpal tunnel
2. Pressure of the first rib or of a cervical rib on the lower trunk of the brachial plexus.

3 Tendinitis or partial rupture of the biceps muscle.
4 Rheumatoid periineuritis, especially if it complicates infective arthritis of the shoulder joint

Seventh Cervical Root

This is by far the commonest root affected at least nine out of ten cervical disc-lesions occur at this level. The pain extends from the scapular area down the back of the arm, via the outer forearm, to the finger tips pins and needles are usually felt in the index, long and ring fingers. Rarely the pain is pectoral instead of scapular I have even encountered a few patients with weakness due to a seventh root palsy who have never had any brachial discomfort at all but only unilateral anterior upper thoracic pain. Some of the neck movements provoked, of course, the pectoral pain the thoracic movements did not, and it was examination of the symptom free upper limb that clarified the diagnosis *The outstandingly weak muscle is* the triceps, the flexors, less often the extensors (or both) of the wrist may be weakened too The triceps-jerk is seldom affected even when the triceps muscle is extremely weak. Cutaneous analgesia is often found at the dorsum of the long and index fingers After severe and prolonged pressure, complete wasting of the mid fibres of the pectoralis major muscle may appear as a triangular depression lying between the parts of the muscle developed from the sixth and eighth myotomes Rarely, a larger part than usual of the serratus anterior is developed from the seventh myotome and partial winging of the scapula results.

Differential Diagnosis

1 Radial palsy from pressure—*e.g.* of a crutch the edge of a chair or bed or fracture of the shaft of the humerus
2 Lead poisoning (always bilateral)
3 Carcinoma of the bronchus.
4 Tennis-elbow
5 Fracture of the olecranon.

Eighth Cervical Root

The pain occupies the lower scapular area, the back or inner side of the arm and the inner forearm; pins and needles are usually felt at the third, fourth and fifth fingers. *The weak muscles are:* the extensor and adductor muscles of the thumb, the flexor and extensor carpi ulnaris. Sometimes the triceps is also weak Cutaneous analgesia may be detected at the fifth finger.

Differential Diagnosis

1. Cervical rib. The muscles derived from the first thoracic myotome are affected
2. Pressure on the lower trunk of the brachial plexus by the first rib (see p. 177).
3. Secondary deposits at the seventh cervical or first thoracic vertebra This is their usual site at the cervical spine and the condition is easy to detect; for the pain is not severe in proportion to the weakness, which is extreme. Moreover, the seventh and eighth roots are both involved, alternatively the eighth cervical and first thoracic, with the result that the whole hand and forearm are virtually paralysed. Disc-lesions in the neck are rarely multiple, and evidence of involvement of two roots immediately suggests secondary neoplasm, whether the radiograph shows bone erosion or not.
4. Pancoast's tumour. The neck movements are of full range and painless, Horner's syndrome and a first thoracic palsy are present; x-ray examination of the apex of the lung soon reveals an opacity.
5. Traction palsy of the lower two roots of the brachial plexus.
6. Frictional ulnar neuritis at the elbow.
7. Tennis-elbow with misleading reference to the fourth and fifth fingers
8. Golfer's elbow.
9. Pressure on the ulnar nerve at the wrist Occupational; or a ganglion connected with the flexor carpi ulnaris tendon.
10. Angina. Athough cervical disc-lesions usually give rise to

scapular pain spreading to the upper limb, cases are occasionally encountered of unilateral reference to the front of the chest. Pain in the neck and the left pectoral area spreading down the upper limb to the ulnar aspect of the hand naturally suggests a myocardial disorder, especially if the patient is no longer young It must also be remembered that in angina thoracic discomfort may be wholly absent and pain felt to run down one or both arms, or even concentrated only at, say, the left elbow, may be the presenting symptom.

First Thoracic Root

Until 1958 I had not encountered a disc-lesion setting up pressure on the first thoracic root, nor a case of infectious neuritis of this root either alone or in combination. Patients referred to me with this provisional diagnosis had in fact, all turned out to be suffering from some other disorder, *e.g* costal pressure, pulmonary sulcus tumour secondary malignant deposits, or pressure on the median or ulnar nerve somewhere between the shoulder and the hand

In that year, a case each of a first and a second thoracic disc-lesion came my way They both displayed the interesting fact that scapular movements stretch the upper two thoracic roots in the same way as straight leg raising stretches the lower lumbar roots.

First Thoracic Root A man aged 80 felt a sudden pain in the pectoro-scapular area while shovelling worse on taking a deep breath. By some hours later the pain had spread down the inner side of the arm to the elbow, and next day a patch of numbness had appeared at the ulnar border of the palm Various neck and arm movements hurt in an uncharacteristic way, but a constant finding at each examination was aggravation of the thoraco-brachial pain by an outward and forward movement of the scapula. No weakness of the small muscles of the hand developed. Treatment by daily head suspension was begun a fortnight from the onset, and recovery was complete in three weeks I have since (1955) seen one more case in which treatment proved unavailing and the symptoms continued unchanged six months later

caused by a postero-lateral protrusion The brachial pain may thus last for years, by corollary, manipulative reduction may prove most successful also after years of pain and paræsthesiæ

3 *Cases of Painless Slow Onset.* The patient finds difficulty in walking and on examination is found to have a bilateral upper motor neurone lesion affecting both legs In vestigation by radiography with a contrast medium shows the lesion to lie in the neck rather than, as had been expected, in the thoracic spine

4 *Cases Resembling Disseminated Sclerosis* The patient starts limping and drags one leg, and is found to be suffering from an upper motor neurone lesion This is often mistaken for disseminated sclerosis or lateral sclerosis After a year or two, a lower motor neurone lesion begins to show itself by causing weakness and wasting of the muscles of one upper limb The diagnosis is then happily clarified and the patient restored to partial health by immediate operation

Though not a neurologist, I have met with five such cases in the past five years and it is most important that a diagnosis of disseminated or lateral sclerosis should not be made too lightly

5 *Paræsthetic Fingers* In elderly patients advanced degeneration with protrusion of disc-substance at one or more lower cervical levels may give rise merely to pins and needles in both hands. This may continue for years unchanged Minor bilateral postero-lateral protrusion has taken place. In due course, pins and needles usually appear in the lower limbs as well—sometimes in the feet only sometimes including the thighs and legs as well This denotes a central protrusion, giving rise to a triple bulge If pressure is exerted on the anterior spinal artery widespread local degeneration of the cord results Hitherto unexplained cases of upper motor neurone lesion in elderly patients have this mechanism as their basis.

The mushroom phenomenon (see p 420) is a rarity at the neck The patient states that as soon as he gets up bilateral cervico-brachial pain with pins and needles in the hands begins This continues until he lies down (*i e* until the affected joint is no longer compressed by the weight of the head) Lifting the head with both hands has often been noted

by the patient as affording instant relief. A weight-relieving collar or arthodesis is the only treatment

Cervical Neurofibromata

These are rare and diagnosis is extremely difficult. Any patient who appears to have a cervical disc-lesion causing root-pain in the upper limb for more than six months should be suspected of a neurofibroma and his case reviewed with this possibility in mind. Naturally enough, articular signs are absent in these cases; for there is nothing the matter with the joint Unhappily, when a cervical disc-lesion with brachial pain has been present for some months and spontaneous cure is well advanced, the articular signs often disappear. In neurofibroma the symptoms usually start distally and spread slowly up the limb Another real difficulty is differentiation from psychogenic pain.

The straight radiograph reveals nothing relevant, but may show misleading narrowing of one or more joint spaces if the patient is no longer young.

If no convincing signs are present, the patient should be kept under observation at monthly intervals: for sooner or later the signs of pressure on the spinal cord must appear, and should be detected early so that myelography and operation can be undertaken at once. I have had to wait as long as eighteen months for the earliest signs of a spastic diplegia from this cause to appear; hence the patient should be encouraged to continue attending.

Osteophytic Root Palsy

The symptoms and signs are quite different from those of a cervical disc-lesion. The bony outcrop grows very slowly thus causing no appreciable aching as it gradually expands to fill the intervertebral foramen. The pressure is applied lateral to the dura mater itself; hence scapular discomfort is absent. The patient merely complains of weakness of the upper limb which examination shows to be due to a complete palsy of one root. Examination of the neck shows merely considerable osteo-arthritis, causing limitation of movement and bilateral discomfort The oblique radiograph shows the osteophyte No treatment is possible.

X RAY EXAMINATION

This yields mostly negative information, showing the absence of tuberculous disease, fracture or neoplastic erosion. But secondary deposits can be detected clinically before erosion takes place to a sufficient extent to show on the radiograph. Wedge-fracture of the body of a vertebra does not set up symptoms after the first few weeks unless the intra articular cartilage is also damaged

Diminution of one or more joint spaces is a commonplace in painless necks Some osteophyte formation is all but universal in other than young patients, and is compatible with a full and painless range of movement. Gross osteoarthritis leads to limitation of movement, not necessarily to any discomfort. Ossification in the anterior common ligament leads to painless stiffness at the affected joint. Congenital fusion of two vertebræ limits movement slightly and is symptomless in itself but leads to overuse of the joints above and below Disc-lesions occur at joints whose space is not visibly diminished and a narrowed joint space, though it shows the disc to be thin, cannot be taken as evidence of protrusion. If a disc-lesion is known to be present, the fact of narrowing does not prove that that joint contains the lesion For example a diminished space at the fifth cervical level is often found in cases of seventh cervical root palsy, *i.e* a sixth cervical disc lesion Lateral angulation at one joint only (as is occasionally seen at the lumbar spine) can never be detected even in cases of gross deformity, *e.g* the neck fixed in full side flexion. Hence, the diagnosis must be arrived at on clinical grounds. Spondylolisthesis may be seen at the third or fourth cervical vertebra. It has no pathological significance and provides no bar to manipulation. The radiograph serves merely to exclude unsuspected disease of other kinds, but in early cases of, for example, vertebral malignant invasion, it cannot even be relied upon always to do that.

The attempted diagnosis of cervical disc-lesion by radiography is proceeding apace nowadays Nothing is more misleading than the radiograph when radio-translucent structures are at fault, and x ray photographs provide the least part of the examination in these common conditions Clinical examination, by contrast, is quick, easy and fully informative.

CERVICAL "SPONDYLOSIS"

Spondylosis is an unfortunate term. It is new and sounds well, but is a blunderbuss name for many different conditions, differing in nature, effect and treatment. Since clinical differentiation is not difficult if the instructions in this chapter are followed, the word should be dropped and replaced by the appropriate diagnosis.

"Spondylosis" at the neck includes·

1. Symptomless osteophyte formation seen radiologically.
2. Osteo-arthritis causing neckache.
3. Symptomless diminution of one or more intervertebral joint-spaces.
4. Osteophytic compression of a nerve-root.
5. Cervical disc-lesion with unilateral scapular pain.
6. Cervical disc-lesion with unilateral root-pain, with or without palsy.
7. Cervical disc-lesion with bilateral scapular pain, root-pain and/or paræsthetic fingers.
8. Cervical disc-lesion compressing the spinal cord
9. The mushroom phenomenon at a cervical level.
10. Compression of the spinal cord by a central osteophytic outcrop
11. Compression of the vertebral artery by the superior articular process where it traverses the foramen of the vertebra above

TREATMENT OF CERVICAL DISC-LESIONS

1. PROPHYLAXIS

Most patients wake up with a stiff neck, obviously as the result of lying for several hours with their head twisted on their shoulders. Intra-articular displacement comes on gradually during this time and on waking they think they 'have been sleeping in a draught." Hence posture at night is the important point in prophylaxis. The patient, if he sleeps supine, should have one thin pillow; if he lies on his side, the thickness of the pillow should be so adjusted that his cervical and thoracic vertebræ form a horizontal line. The habit of lying prone in bed, so useful for patients with

lumbar disc-lesions, results in the head being kept rotated for a long time during sleep Patients should be warned that this otherwise beneficial position must be avoided once stiff necks have begun to show themselves

By day it is the maintenance of the cervical lordosis that keeps a fragment of intra articular cartilage in place Patients liable to stiff necks, or who have had a displacement reduced must avoid keeping the neck bent for a long period they should extend the neck every so often for a second or two when reading, writing sewing knitting etc.

Since untreated cervical disc-lesions, even though they start by merely setting up some scapular aching may end by giving rise to a severe attack of brachial pain, the true nature of this symptom should be widely recognized and manipulative reduction undertaken at once Were this always done, the disorder once known as 'brachial neuritis" would all but disappear, for then only the occasional case in which the symptoms start in the forearm and hand would escape recognition. This would imply the abandonment of treatment by heat and massage for cervico-thoracic fibrositis" and its substitution by manipulation during traction Indeed, much of the scepticism with which doctors view massage is based on the fact that they themselves order massage for a condition intractable by this means, but easily reversed by manipulation.

Since knowledge of the technique of manipulative reduction at the neck has not yet been acquired by the medical auxiliaries to whom these patients are normally sent for treatment, many thousands of patients suffer unnecessarily because, though the disorder is recognizable and a simple remedy known far too few persons in proportion to the frequency of the condition have been trained to carry out the necessary manœuvres.

2 REDUCTION BY MANIPULATION

This is the obvious treatment no less so at the neck (see Vol II) than, say at the knee. Unless there is some good reason, manipulative reduction should be attempted within the hour It is my habit to carry this out as soon as the diagnosis is established for waiting some hours or a

day may make a great difference to the reducibility of the protrusion. This fact should be pointed out to patients who, usually because of some important engagement later in the day, wish to defer treatment until the morrow.

Contra-Indications

Evidence of an upper motor neurone lesion should lead to immediate operation. However, a central posterior protrusion may exist not yet large enough to interfere with conduction along the spinal pathways. In such a case, the first symptom is usually pins and needles in both feet. A patient with a cervical disc-lesion with this symptom but no signs as yet of pressure on the spinal cord may be treated by an attempt at manipulative reduction, but it must then be most carefully carried out with a *maximum of manual traction and a minimum of articular movement.* If it fails, traction in recumbency is urgently indicated, if, as is very uncommon, that too fails or reduction proves unstable (occasionally met with) laminectomy is called for.

The following account describes a central cervical disc-protrusion—the first such case I ever tried reduction on—effectively treated by manipulation.

In 1948 a medical man, aged 44, while driving his car, noticed that each time he flexed his neck fully he felt pins and needles in all four limbs. These paræsthesiæ had persisted unchanged for three weeks before he was seen.

Examination showed no signs of a lower motor neurone lesion affecting the upper limbs, nor of an upper motor neurone lesion affecting the lower limbs; the patient merely experienced the paræsthesiæ each time he flexed his neck. In view of the absence of evidence of cord compression, after discussion of the issues involved, we agreed that manipulative reduction at the neck should be attempted.

After the first attempt, neck-flexion ceased to affect the upper limbs, but still set up paræsthesiæ in both lower limbs. A week later, after the second manipulation, neck-flexion gave rise to pins and needles in only one thigh and calf. The third manipulation abolished all the symptoms, and there had been no recurrence by five years later

Criteria of Reducibility or Not by Manipulation

Two questions must be answered (*a*) How large is the protrusion? (*b*) Do articular movements affect it?

(*a*) The larger the protrusion, the more marked the neurological signs Hence considerable weakness of muscles shows the herniation is larger than the aperture it emerged from, therefore it cannot be put back. (*b*) If several of the neck movements set up or markedly increase the scapular aching, the displacement clearly lies where the articular movements influence it. Such "good" neck signs suggest reducibility

The possibilities are —

1 Scapular pain without root pain Good or bad neck signs without neurological weakness Reducible in 1 or 2 sessions 2 Unilateral scapular pain with root pain. Good neck signs, no neurological signs Almost certainly reducible 3 Unilateral scapular pain with root pain Neck movements hurt down the upper limb as well as in scapular area No neurological weakness Probably irreducible 4 Bilateral scapulo-brachial discomfort with paræsthetic hands and/or feet. Fair neck signs, no neurological signs About half are reducible in 4 to 8 sessions 5 Unilateral root pain followed by scapular pain Symptoms start at the hand and progress slowly upwards to the scapular area Such primary posterolateral protusions, as at the lumbar spine, are irreducible. *N.B* Cervical neuromata often start this way 6 Unilateral scapular pain with root pain Good neck signs and minor neurological signs Sometimes reducible, especially if the brachial pain has lasted less than a month. 7 Unilateral scapular pain with root pain. Poor neck signs and major root palsy Certainly irreducible. 8 Unilateral scapular pain and root pain of more than 6 months' standing Fair neck signs and a recovering root palsy One manipulation will often restore full and painless movement to neck, abolishing scapular ache Root pain usually continues unchanged but slowly disappears during the next month as a rule. 9 Unilateral scapular pain persisting for months after a root pain has ceased Only one neck movement elicits the discomfort. Irreducible 10 Paræsthetic hands and/or feet. Neck flexion evokes the symptoms Gait not spastic Plantar response flexor Usually reducible. 11 Elastic recoil. Rarely manipulation is confidently started in a

patient with signs suggesting that reduction by manipulation will prove simple. When this is attempted, however, a rubbery rebound is felt when the extreme of passive rotation is reached No matter how often this movement is forced, apparent full range being achieved each time, no increase in the active movement is found when the patient sits up. Sometimes pulling strongly without appreciable rotation is effective; sometimes achieving full rotation and holding this position for half an hour restores range. If these methods fail, it is wise to pass on at once to sustained traction in bed

Gross Deformity

Gross side-flexion deformity with brachial pain (such that the patient's ear lies almost on his shoulder) cannot be treated by manipulation, daily head-suspension for one or two months is required. If such deviation exists with merely scapular pain, manipulation can be carried out provided it is given repeatedly in the line of the deformity until the neck can be held painlessly in the mid-position. Most dangerous treatment—far worse than doing nothing—is to push the head over the other way during anæsthesia Gross intractable fragmentation of disc substance, severe root-pain or pressure on the spinal cord often results. A slight lateral deviation is no contra-indication, it merely means that reduction will be more difficult to achieve than when such deformity is absent.

Patients who hold their chin on their chest, hardly able to extend the neck at all, have a pulpy herniation lying posteriorly and centrally. Manipulation in such cases must be very gradual, involving a great deal of traction without, at first, any attempt being made to extend the neck; otherwise the manipulation carries with it the risk of increased posterior protrusion with damage to the spinal cord. It is well to warn the patient that reduction will have to be very carefully performed and that the whole process may well take an hour.

Anæsthesia

General anæsthesia is strongly contra-indicated; for a set manipulation is not performed. What to do next, and whether to stop or go on, depends on re-examination after each manœuvre. When it appears to be required, *i.e.* because the displacement proved irreducible in its absence, those who try will find that those protrusions that could not

be reduced without anæsthesia cannot be reduced with anæsthesia either Anæsthesia leaves the manipulator wholly in the dark, depriving him of that most essential factor—the patient's co-operation Adequate relaxation is easily secured by mere persuasion. After each manœuvre, the conscious patient sits up and moves his neck, the manipulator assesses the effect on the range of movement and the patient on the degree of pain. In consequence, it is possible at once to know if any one manipulation has done good, has had no effect, or has done harm, and the next step is based on this knowledge It is my view that only the patient's active co-operation renders manipulation in cervical disc lesions simple, effective and really safe.

This contrasts with the treatment of osteo-arthritis, when general anæsthesia, though strictly speaking not required except for very sensitive patients, enables capsular stretching to be painlessly carried out. Since a routine manipulation is performed, the patient's conscious collaboration is not needed

Manipulative Technique

Most protrusions are suited to manipulative reduction Failure occurs in only one in ten cases The pain in the arm and the paræsthesiæ in the fingers, if these are present, are usually abolished first the scapular pain is the last to go Numbness takes a long time to wear off after reduction for it is due to past pressure on the parenchymatous element in the nerve-root. Thus it may persist for a week or several months rarely it is permanent.

An experiment was made to find out how much pull I exerted when reducing a cervical disc-lesion The maximum was found to be 300 lb Miss Moffatt, my senior physiotherapist at St. Thomas's, reached 220 lb

Radiography was carried out before and during fairly strong traction on the neck. It showed that traction increased each joint space by 2 5 mm.—in other words almost doubled the distance between the bones No wonder cervical disc lesions are not difficult to reduce as long as the traction is adequate.

Dr P Flood's report runs

"Two antero-posterior films were taken. The first

before pull was applied and the second while you pulled on the head. In the preliminary film the distance between the upper surface of the first dorsal vertebra and the upper surface of the fourth cervical vertebra is on measurement 7 cms.; during pull this distance is increased to 8 cms In order to avoid magnification the position of the spine relative to the film was, as far as was possible, similar in both cases. This is confirmed on measurement of the transverse width of the spine which does not vary by more than a millimetre.

"The increase of 1 cm. over the distance of the bodies of the lower four cervical vertebræ must therefore be due to opening of the intervertebral spaces" (see Plates 5 and 6).

The techniques (see Vol II) are:

1. Traction with circumduction during extension.
2. Rotation during traction.
3. Side-flexion during traction.
4. Antero-posterior gliding during traction.
5. Side-gliding without traction.
6. A straight pull with leverage (mainly for central protrusions).

They are usually attempted in this order. A manipulation is performed, then the patient sits up and estimates the result, if any, on his symptoms; the manipulator observes the result on the range of movement. If a manipulation does good, it is repeated; if it does harm, it is repeated in the opposite direction. If this does harm too, manipulative reduction should be abandoned. If the first two manipulations do no good, the third should not be attempted; for it will probably increase the pain, especially if side-flexion towards the painful side is carried out. The fourth manipulation is required only when a patient has recovered a full range of every movement except extension, which remains obstinately limited. The fifth manipulation takes away the general soreness left over after successful manipulation. Manipulation should be carried out daily, or at least every other day, until reduction is achieved; one to four sessions may be required. If a patient is not fully relieved, or almost so, after four treatments properly given, he must be regarded as having a protrusion that cannot be reduced by manipulation.

Maintenance of Reduction

If a loose body in a joint has moved once it can move again Patients with only cervico-scapular pain often describe a number of previous attacks, and others are to be expected unless the patient is careful about the posture of his neck, especially at night (see p 162) Any displacement that nevertheless recurs should be reduced again at once. The patient must be warned that the longer a protrusion is left unreduced, the more capsular stretching results and the greater the likelihood of recurrences and the eventual supervention of root pressure. Even if previous attacks have proved self limiting, there is no guarantee that in the present attack the size of the protrusion is not about to increase and root pain to begin Hence, immediate complete reduction is the first line of defence.

Recurrence after root pressure that is allowed to run its full course untreated is very uncommon By contrast, if reduction is carried out in cases of root pain, the position is the same as in scapular pain—namely the protrusion has gone back to its original bed and recurrence becomes a real possibility

A Moulded Collar It occasionally happens that reduction, though fully achieved, proves very unstable This is most apt to occur in protrusions of some years' standing and after ill advised manipulation under anaesthesia

A moulded plastic collar is made being transparent, it is remarkably inconspicuous (see Plate 7) It must support the mandible well, and the occipital piece must not tend to push the head forwards. The neck piece must be tall enough to carry some of the weight of the head. When careful trying on shows that the collar fits, the patient's disc lesion is reduced again and the collar applied while he remains lying on the couch. It should be worn by day for three or four months. Then it should become possible to discard it. It would naturally be an advantage if it were worn by night as well in the first few weeks, but it is rare to meet a patient who can sleep in it. If the displacement recurs during the night, reduction by manipulation must be repeated

The main contra indication to a collar is osteo-arthritis of the cervical spine. Since this condition comes on in middle-age, the radiograph is sure to show a diminished space at one

or more cervical joints; hence the disorder is often regarded mistakenly as a disc-lesion. If a collar is then prescribed, the immobility increases the stiffness and capsular contracture, and symptoms may be lastingly enhanced or require a good deal of treatment for their abolition.

A few patients find that a head-suspension apparatus (see Vol. II) installed at home suffices to keep them comfortable if it is used either as soon as discomfort appears or as a routine for, say, a quarter of an hour daily. Others find that they can restore movement caused by a recent and minor subluxation by active exercise while the head is floating. The patient lies supine in a warm bath, only his nostrils projecting above the surface of the water. The weight of the head is now borne by the water; hence compression strain on the joint ceases. Active movements can now be accomplished and a position previously unattainable held for some time. If carried out early enough, reduction often ensues.

8. PROLONGED TRACTION

There are three ways of doing this. (1) The patient may attend for head-suspension (see Vol. II). Immediately after manipulative reduction, this measure is also useful as it tends to achieve greater stability of the loose fragment. (2) Alternatively, he may attend the department and lie on a tilted couch most of the day with 10 to 20 lb. traction on his head; this is not often worth while. (3) By far the best method of treatment for cervical disc-lesions causing severe pain and irreducible by manipulation is traction in recumbency. It should not be attempted without ample justification, however; for patient, nurses and doctor are all apt to find the method most trying. The chief indication is really severe brachial pain caused by an irreducible pulpy protrusion. Traction, however prolonged, does not reduce cartilaginous displacements and I have on a number of occasions easily reduced a displaced fragment of annulus causing severe root-pain in patients who had had up to a fortnight's traction in bed in other hospitals.

A particularly good example of this fact occurred early in 1950, when a patient came up with agonizing pain in his arm due to a cervical disc-lesion. I had seen him several

times before with less severe pain in his arm and on each occasion reduced the displacement by one manipulation This time he appeared to me to have such severe pain as not to be able to allow an attempt to be made, he was therefore admitted for sustained traction in bed At the end of ten days he still had as much pain as ever, the harness was removed and manipulative reduction performed with immediate full success

Traction in bed is best carried out in hospital, for the patient requires full nursing day and night. He cannot feed himself or move his head appreciably The principles of treatment are (1) to give the patient enough drugs to prevent his feeling the pain of the collar and that down his upper limb (2) never to allow the traction to abate for one moment. The well intentioned nurse who tries to adjust the collar, meanwhile relieving the traction, ruins the success of this method. A clear instruction should be given that no one must touch the harness or weights So long as the severe brachial pain continues, it overshadows all else and the patient causes little trouble. Moreover he is kept well drugged. Heroin (¼ grain four hourly) is much preferable to morphia otherwise vomiting may make removal of traction imperative.

Ten or twelve pounds traction day and night is maintained during heavy sedation until the brachial pain ceases —usually in twenty to forty hours. Traction is then diminished in force, and after some days the patient is allowed to lie without weights for increasing periods. At the end of five to seven days he sits up for short periods. Hence, even in the most satisfactory case in which all pain ceases at the end of twenty four hours seven days in bed are the least that can be hoped for more often ten days elapse before the patient is fit to go home. As soon as the pain ceases and the stronger analgesics are no longer required, the patient makes every sort of complaint about the collar and indeed every aspect of his treatment he becomes difficult and may need several visits a day Not being in any way ill, he has plenty of will power hence traction in bed, though extremely effective, should be embarked upon on all sides with great reluctance (For details of apparatus, etc., see Vol. II)

local anæsthesia induced about the nerve-trunk led to immediate abatement of the symptoms, sometimes lasting. I used to give an injection there of procaine once a week, with gratifying results to the patient.

The second is local anæsthesia induced at the stellate ganglion. Almost any sort of pain felt in the upper limb may be temporarily or lastingly relieved by this manœuvre (see p. 616) and it too may be repeated at, say, weekly intervals until the patient's pain has subsided.

5. OPERATION

Laminectomy is hardly ever required for protrusions at any cervical level. Five phenomena, however, all rare, suggest the need for operation: (1) Signs of pressure on the spinal cord. Symptoms (*i.e.* pins and needles in the lower limbs) alone do not necessarily contra-indicate an attempt at reduction by manipulation or by traction in recumbency. But, should these paræsthesiæ not disappear, operation may be indicated. Signs, however, of an upper motor neurone lesion call absolutely for urgent removal of the protrusion at laminectomy. (2) Increasing weakness of the hand in eighth cervical root-pressure. Whereas a fifth, sixth or seventh cervical root-palsy can be relied on to recover completely with the passage of time, no such guarantee exists when the eighth root is severely compressed. Permanent paresis of the thumb muscles is by no means uncommon, and adduction is often lastingly so weakened that the patient remains unfit for all employments involving strength and grip. If the hand of a patient with an irreducible seventh cervical disc-lesion gets progressively weaker, operation confers the only chance of restoring the strength of his thumb. (3) Irreducible protrusions giving rise to severe pain lasting for more than four months. These are very rare. (4) Reducible protrusions that keep recurring in spite of an adequate collar. Laminectomy is of course possible only in cases in which the neurological signs indicate the level of the protrusion. (5) Irreducible or recurrent protrusions giving rise to gross lateral deviation of the neck. Again, laminectomy is possible only if the level can be determined clinically or by myelography.

The operation is dangerous, even when performed by an

expert Permanent paraplegia from post-operative intra spinal hæmorrhage is by no means unknown. Hence it should be decided upon with great reluctance

TREATMENT OF CAPSULAR DISORDERS

The degree of osteo-arthritis must be assessed clinically, not by radiography

In early osteo-arthritis or in post traumatic stiffness of the cervical joints, the manipulation consists of a series of quick jerks, rupturing adhesions (see Vol II) Traction is not required.

Traumatic osteo-arthritis in middle-aged patients often appears uninfluenced by treatment, but since many of these patients are claiming compensation it is difficult to be sure of this apparent finding

In more advanced osteo-arthritis, capsular contracture is present and leads to considerable limitation of movement. The same manipulations are performed, but now they are carried out with the slow strong pressure calculated to stretch out a tough structure. As a result, not only is the pain in the neck abolished, but the occipito-frontal headache disappears as well. Many elderly patients, by coming for such a manipulation once every twelve months or so, can be kept comfortable for many years, though a full range of movement is never restored to the cervical joints General anæsthesia is occasionally requested by sensitive or apprehensive patients, and makes the manipulator's task somewhat easier There is no upper age limit to manipulation, which can be safely carried out after the age of eighty However, only one movement may be forcible at a session hence the really elderly patient may have to come two or three times for as much treatment as, had he been ten years younger, could have been carried out at one session.

In osteo-arthritis complicated by a loose body displaced within one joint, manipulation is performed on the same lines as for the disc-lesion in younger patients. Reduction must be attempted with due regard for the patient's age, blood pressure, capacity to bear pain and range of movement at the cervical joints. Properly carried out, manipulation is

referred to the distal part of the upper limb The nerves derived from the eighth cervical and first thoracic roots—*i.e.* the lower trunk—are affected; hence the mere discovery of a palsy at or above the seventh cervical level rules out costal pressure as its cause.

There are two main types of costal pressure: (1) that associated with a cervical rib, and (2) that associated with the first rib. Cervical ribs show, of course, on the radiograph, but it must be remembered that patients with every gradation of bony abnormality, from unusually long transverse processes at the seventh cervical vertebra to large cervical ribs, may suffer no relevant symptoms at all. It is thus, as always, the discovery of distinctive physical signs that serves to demonstrate the pertinence or not of the abnormalities disclosed by x-rays. The mechanism of costal pressure is shown in Fig. 25.

1. CERVICAL RIB

The symptoms are wholly distal and more often related to pressure on nerves than on the subclavian artery. Pins and needles and numbness of median or ulnar distribution, more often the latter, are commonly the first symptoms. The complaint is usually bilateral, but often more severe on one side than the other. The patient, who is usually in his twenties or thirties, notices that carrying anything heavy or even wearing a winter overcoat brings on the paræsthesiæ in the hands. Sometimes he states that dependence of the arm for any length of time is followed by aching in the hand, which remains white and cold for some hours. This can be confirmed objectively, and indicates pressure on the subclavian artery. If the pressure is exerted on the subclavian vein, the hand may become œdematous and, less often, cyanosed for hours or days. Occasionally, he is concerned to see that, albeit painlessly, bilateral wasting of the abductor pollicis brevis muscle has slowly become complete over a period of years; the patient then attends merely to find out the cause of the alteration in the contour of his thenar eminence.

Examination shows that the scapular elevation, and holding the arms right up for a while, affect the symptoms.

Whether the effect is towards aggravation or relief is diagnostically immaterial. In a very few instances, approximation of the scapulæ draws the clavicles backwards and sets up the distal paræsthesiæ these are the rare cases to which the term costo-clavicular compression can be properly applied Approximation of the scapulæ may also abolish the radial pulse not an uncommon phenomenon in normal individuals. Passive depression of the scapulæ by the examiner seldom has any effect, but making the patient carry a weight for some time may increase or bring on the symptoms Palpation at the root of the neck anteriorly may reveal a unilateral increase in the ease with which subclavian pulsation is felt. By contrast with these scapular findings, the movements of the neck are free and painless and examination of the upper limb usually reveals no abnormality This in itself suggests pressure at the thoracic outlet for the other causes of pain in the upper limb associated with paræsthesiæ felt in the hand normally give rise to clear physical signs

Radiography shows the cervical ribs It must be borne in mind that supernumerary ribs visible on the radiograph do not necessarily cause any symptoms

In due course, in cases of median development, wasting of the abductor pollicis brevis muscle begins to show itself In cases of ulnar development, the hypothenar and interosseous muscles weaken. Cutaneous analgesia is seldom a prominent feature. After some years, all the small muscles of the hand and the flexor digitorum profundus to the fourth and fifth fingers may become very weak.

2 PRESSURE EXERTED BY THE FIRST RIB

Acute Onset

Rare cases occur of pressure at the thoracic outlet occurring suddenly A young person after carrying a heavy weight for some distance—usually a suitcase on a journey—suddenly feels faint and develops pain in the chest and upper limb Within a few minutes the hand and forearm blanch, but, since breathing usually hurts, consequent shallow respiration often leads to the patient's immediate admission with a provisional diagnosis of spontaneous pneumothorax The radial pulse

these muscles are extremely strong in all healthy individuals. In the second place strengthening a muscle in no way hinders it from fully relaxing when not in use. The patient must learn to keep her shoulders very slightly shrugged all the time, in other words to maintain a slight constant postural tone. This habit can be inculcated; giving exercises consisting of making the muscles contract and then relax misses the point altogether. Before lifting anything heavy she must shrug her shoulder right up and maintain this position of her scapula all the time that she is carrying the weight So far as possible, she must avoid wearing an overcoat. A basket on wheels is a great help to the housewife. Provision of domestic help fully relieves some patients, as study of the history may indicate.

(3) *The Armchair.* Each evening, after supper, she must sit in an armchair with her arms adducted to her sides and the forearms so supported on the arms of the chair that the scapulæ are held well up without effort on her part. After a while, this posture results in the appearance of the familiar symptoms. She remains seated thus until the paræsthesiæ have ceased, however long this may take—at first often twenty to thirty minutes, later only a few minutes. The nerve-trunk having now recovered, she can go to bed, free from fear of being woken.

(4) *Support.* Occasionally, it is wise to take the downward strain off the thoracic outlet. In unilateral cases, a sling can be worn bearing on the other shoulder only. In bilateral cases it is necessary to provide a belt with adjustable gutters supporting the upper forearm (see Fig. 26). The patient rests her elbow on the gutter all the time that the arm is not in active use.

(5) *Rest in Bed.* In severe cases some days' rest in bed may be required as a start to treatment.

(6) *Stellate Block.* Local anæsthesia induced at the stellate ganglion is said to relieve the symptoms lastingly, but I have not found this so.

SCAPULO-THORACIC CREPITUS

When one or other scapula—sometimes both—is actively moved up and down against the thorax painless crepitus

may be palpable. Occasionally, a loud creaking audible across the room is provoked If the scapulæ are abducted, the crepitus on movement ceases. Hence the condition is clearly due to roughening of the posterior thoracic wall just beyond the lateral edge of the ilio-costalis muscle.

When the crepitus occurs in young people, much concern may be aroused lest the crepitus prove the precursor to rheumatism." Explanation that the crepitus lasts indefinitely but possesses no evil significance is usually all that is required by way of treatment.

Occasionally the patient complains of considerable scapular aching after exercise. Typists, gymnasts and physiotherapists may become scarcely able to work. In such cases the area whence the crepitus originates must be outlined by discovering just how far the scapula need be abducted for the crepitus on movement to cease. The roughened area now lies just medial to the vertebral border of the upper scapula Deep massage must be given to this spot. The patient feels no special tenderness here, the physiotherapist cannot feel any crepitus as she gives the massage hence the spot must be found mathematically The crepitus on scapular movement does not cease yet ten to twenty such treatments largely or wholly abolish the ache, even when it is of many years standing

The patient may begin to develop a tic, moving his scapula repeatedly so as to elicit the crepitus this naturally increases the ache, though he imagines that the action provides temporary relief Explanation to the patient that this habit must be resisted suffices.

Should massage fail and the symptoms warrant, excision of the upper inner angle of the scapula affords permanent cure, but I have yet to meet a sufficiently resistant case.

THE TEMPORO-MANDIBULAR JOINT

When this joint is affected, the patient himself nearly always supplies the diagnosis. It should not be forgotten that a painless stiffness of this joint may be the first symptom of tetanus

Examination. The patient is asked to open and close the mouth, to deviate the mandible to right and left and to

protrude it forwards. He then clenches his teeth and attempts to open the mouth against the examiner's resistance under his chin. The joint is then palpated while the patient opens and shuts his mouth and deviates each way. The examiner's finger should be placed just below the zygomatic process when opening is examined, and in the external auditory meatus when the jaw closes.

Whether or not each condyle of the mandible moves forwards or not on to the articular tubercule can be felt, together with any click or crepitus

1. *Clicking Jaw*

This is due to a momentary luxation of the intra-articular meniscus. It can usually be relieved by so strengthening the muscles of mastication that they hold the jaw steady. To this end resisted exercises are practised, *i e.* opening the mouth, protrusion and lateral deviation. There is seldom any need to give a resisted exercise to the muscles that close the jaw; for these are the ones that the patient maintains for himself by chewing. If dislocation of the meniscus takes place during the exercises, this must be prevented by the physiotherapist's finger pressed against the side of the jaw while the movements are resisted with the other hand.

2. *Fixed Dislocation of the Meniscus*

When this occurs the patient finds himself suddenly unable to open his mouth more than a short distance. This limitation of movement might be attributed to arthritis, but

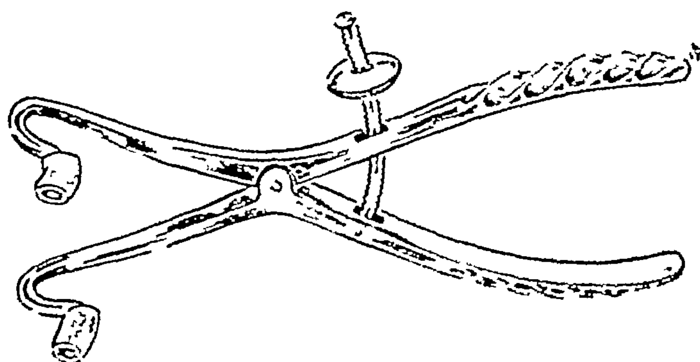


FIG. 27.—Dental gag. For reducing a dislocated meniscus at the temporomandibular joint.

full closing of the jaws is painless, thereby indicating a full range in one direction. Lateral deviation towards the affected side is usually painless and may be the position of ease.

Reposition usually requires general anæsthesia, the patient's jaws being merely forced apart with a dental gag until the meniscus slips home (see Fig 27) Reduction by this means presented no difficulty in a case of two years' standing

3 *Osteo-arthritis*

If this causes symptoms, there is pain on, seldom limitation of, the extreme of each movement. Treatment consists of deep friction to the capsule of the joint followed by forcing movement (see Vol. II)

4 *Sympathetic Arthritis*

A day or two after the extraction of molar teeth, the patient may notice increasing difficulty in opening his mouth. Examination shows movement to be limited in every direction and the bone in the region of the tooth-socket to be tender This type of sympathetic irritation of the joint appears analogous to that occurring in connexion with any abscess near the extremity of a bone

Spontaneous cure of the arthritis may take two or three weeks. Recovery is probably hastened by short wave diathermy applied to the region of the tooth socket. Since the lesion and the joint lie so close together the area heated may well include the temporo-mandibular joint Alternatively, penicillin may be employed locally or parenterally to combat the sepsis

5 *Non specific Arthritis*

Occasional cases are seen of arthritis of one temporo-mandibular joint coming on for no apparent reason. No connexion can be detected with rheumatoid arthritis, gonorrhœa, Still's disease, or spondylitis deformans

In the course of some weeks the patient develops increasing pain in the cheek and inability to open the mouth, often to the

protrude it forwards. He then clenches his teeth and attempts to open the mouth against the examiner's resistance under his chin. The joint is then palpated while the patient opens and shuts his mouth and deviates each way. The examiner's finger should be placed just below the zygomatic process when opening is examined, and in the external auditory meatus when the jaw closes.

Whether or not each condyle of the mandible moves forwards or not on to the articular tubercule can be felt, together with any click or crepitus.

1. *Clicking Jaw*

This is due to a momentary luxation of the intra-articular meniscus. It can usually be relieved by so strengthening the muscles of mastication that they hold the jaw steady. To this end resisted exercises are practised, *i.e.* opening the mouth, protrusion and lateral deviation. There is seldom any need to give a resisted exercise to the muscles that close the jaw; for these are the ones that the patient maintains for himself by chewing. If dislocation of the meniscus takes place during the exercises, this must be prevented by the physiotherapist's finger pressed against the side of the jaw while the movements are resisted with the other hand.

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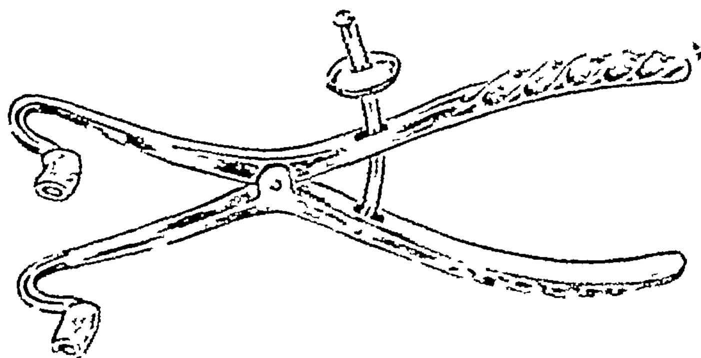


FIG 27.—Dental gag For reducing a dislocated meniscus at the temporomandibular joint.

CHAPTER IX

THE SHOULDER

PART I LIMITED RANGE

THE problems discussed in the three following chapters concern the nature and site of the numerous painful processes that occur in the shoulder region, and the factors governing the choice of treatment. The possible lesions are many and special difficulties attend their identification, since the pain is much the same whatever its source, but with careful examination and an unhurried weighing up of the evidence thus collected, a correct inference can nearly always be drawn. Double lesions are encountered more often than is realized

POSSIBLE SOURCES OF PAIN IN THE SHOULDER

Pain about the shoulder may arise at the following sites and in the following ways

1 The shoulder joint.
2 The subdeltoid and subcoracoid bursæ
3 The muscles and tendons about the shoulder
4 The acromio-clavicular joint
5 The costo-coracoid fascia
6 By reference distally from the tissues forming the base of the neck and upper thorax, including the cervical nerve-roots, the subclavian artery, the lower trunk of the brachial plexus, the first rib the heart and the diaphragm.
7 By reference proximally from the nerve-sheaths in the arm, at the elbow or at the wrist.

To make matters yet more complicated, pain arising in the structures that form, or control, the shoulder joint may be felt at a distance only Indeed, pains which in fact arise at the shoulder may be felt most intensely at the lower deltoid area, or in the arm just above the elbow, rarely the symptoms

STERNO-CLAVICULAR JOINT

This joint allows some 60° range of elevation, 60° of rotation and 30° of forward movement, the range being limited by the fact that the scapula has reached its extreme of range.

The joint may be sprained as the result of a fall and any capsular stretching that occurs there is permanent. The weight of the upper limb makes the medial end of the clavicle ride upwards, after capsular rupture, as far as the costo-clavicular ligament permits. A permanent prominence is then visible. Subluxation is common also in osteo-arthritis and after a bacterial infection.

The patient himself supplies the diagnosis; for the pain is felt exactly where the joint is and does not radiate. Movement at the joint produced by the active scapular movements evokes slight discomfort as a rule, but resisted flexion of the neck, by pulling the clavicle upwards via the contracting sterno-mastoid muscle, usually brings on considerable discomfort. Palpation shows the joint to be prominent and tender. In osteo-arthritis the joint may appear swollen and feel soft in a manner more suggestive of rheumatoid arthritis, but this finding need not arouse alarm. Syphilis is said to have a special predilection for the inner end of the clavicle, but this appears no longer so.

In recent sprains, a sling should be worn to relieve the joint to the weight of the upper limb and kept on until the joint ceases to hurt—usually a fortnight. Subsequent instability, provided that it is painless, is no inconvenience to the patient. Persistent pain after a sprain is best treated by an injection of 25 mgr. hydrocortisone into the joint. Exercises are contra-indicated since the sterno-clavicular joint is dependent for stability on ligament alone; hence movements cause only further stretching. This does not imply, of course, that in other than the young, a full range of movement need not be maintained at the shoulder-joint; this is standard practice whenever a sling is worn

In chronic cases, pain follows exertion (the joint is already osteo-arthritic or subluxated), and may continue indefinitely in spite of rest. Hydrocortisone by injection abolishes the symptoms, but the patient must permanently avoid exercise after that.

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even occupy only the forearm or the wrist. These pains may entirely omit the shoulder region and often radiate to the hand, though not to the fingers.

At the shoulder, identical symptoms may arise from different lesions. Since the shoulder-joint, the muscles and tendons about it, the subdeltoid bursa, and the scapular muscles all possess a similar embryological origin, affections of any of them set up the identical referred pain. Furthermore, the same lesion, when its severity alters, may at different times give rise to pain at quite different sites; for the symptoms are confined only by the segmental boundaries.

No matter what the position of an articular or para-articular lesion at the shoulder may be, if it is severe, the patient feels a deep burning ache running down the arm and forearm. He has little idea of its source; if he indicates an exact point, he is often wrong. Whenever such diffuse pains are met with in the upper limb, examination of the entire forequarter is always required for reaching an accurate diagnosis. Nor must the examiner stop when one disorder has been identified; for combined lesions are fairly common in this area

PRESENT-DAY MISCONCEPTIONS

There are a number of important errors in current medical thought on the shoulder. As long as these are uncritically accepted, the physician has difficulty in interpreting correctly his own findings on clinical examination. By far the most important error is that of ascribing capsular lesions to disorders of the tendons about the joint. This is considered below.

TENDINOUS LESIONS THOUGHT TO CAUSE LIMITATION OF MOVEMENT

It is clear from the writings of medical men on both sides of the Atlantic that there is a widespread and entirely mistaken belief that limitation of movement at the shoulder can result from tendinous lesions. This concept bears no relation to what is found on clinical examination of painful shoulders, provided that, as I recommend, the function of the tendons

and joints is tested separately It is a neat idea, welding degenerative changes in the biceps and supraspinatus tendons to subsequent capsular changes causing arthritis A pleasant unity is thus created but alas without justification. Tendinous and capsular lesions at the shoulder are quite separate and each may be present for years without affecting the other, they do not merge however long the patient is kept under observation.

Bicipital tendinitis is held by many authorities to be the forerunner of a frozen shoulder In fact, the tendon of the long head of biceps does not move during abduction of the humerus, the bone gliding under the stationary tendon. Were the tendon to become inflamed or fixed to the bone, it is conceivable that limitation of adduction of the humerus might in theory result, but passive abduction could not become limited. If the tendon is frayed degenerated or chronically inflamed, pain on resisted flexion and supination of the forearm may ensue, nothing else.

More recently orthopædic opinion has leant towards the rotator cuff as the primary lesion in a frozen shoulder This alternative is equally mistaken. Though a partial lesion in the belly of a muscle may lead to localized spasm about the affected fibres, and thus to limitation of movement in the *one* direction which stretches that muscle, it cannot lead to limitations of movement in more than one direction, let alone in all. The idea that tendinous disorders can limit movement at the shoulder has arisen in two ways These are set out below

1 Because of the difficulty often experienced in distinguishing between the earliest stage of the freezing shoulder and a tendinous lesion. This is merely due to insufficient care and understanding in clinical examination

2 Because injury to both the capsule of the shoulder joint and the supraspinatus tendon is fairly common As a result of the tendinous lesion the patient has considerable pain on attempting active abduction. He therefore avoids this movement and the damaged shoulder joint develops post traumatic adhesions Thus a traumatic supraspinatus tendinitis accompanied by a full range of movement at the shoulder joint may later lead to a joint at which limitation of movement from disuse has occurred

Brief reflection on simple mechanical facts must convince

anyone, I hope, that short of ossification, no conceivable lesion of the supraspinatus tendon could set up limitation of passive abduction, let alone of passive rotation, at the shoulder-joint. However, this notion leads to the theory that limitation of movement at the shoulder can result from primary contracture of the rotator cuff about the joint. It would be most remarkable if alone amongst the muscles of the body, the biceps, supraspinatus, infraspinatus and subscapularis muscles were causelessly to develop such a primary contracture. Moreover if they did, the pull of the infraspinatus and subscapularis muscles would cancel each other out, leaving the arm fixed in *abduction* by the unopposed contracture of the supraspinatus muscle. Since the shoulder never becomes spontaneously fixed in abduction, this tendinous hypothesis should be abandoned forthwith. The same error was made by the orthopædic surgeons of a past generation who named arthritis of the tarsal joints "spasmodic pes planus," because they noted the peroneal muscle spasm and regarded it as primary Manipulation of a freezing shoulder in the early stage, since it gives rise to none of the cracks of breaking adhesions, has been held to prove that the joint is not affected primarily. It would be as reasonable to deduce that, when an early infective arthritis of the knee is moved under anæsthesia, the absence of articular sounds shows the primary cause for limitation of extension to lie in the hamstring muscles. Since the knee is warm and swollen, palpation focuses attention on the joint, even though the radiograph reveals no abnormality. Palpation of the shoulder-joint is not practicable; hence the liability to misconception. In fact, even advanced lesions of the tendinous cuff about the joint, as well as of the long head of biceps, have been shown by de Palma's excellent post-mortem studies (1950) to be compatible with full and painless function of the shoulder. Hence, even the discovery of various marked abnormalities of the tendinous cuff at operation or dissection provides no real evidence that these were the original cause of a patient's symptoms. Clinical examination, however, on the lines laid down clarifies these problems at once.

Other difficulties in connexion with the shoulder are less fundamental and largely associated with terminology. These are:

1 "*Brachial Neuritis*" *and* "*Brachial Neuralgia*"

In the past, the phrases have been used to designate any diffuse pain of unknown origin felt in the upper limb In my view, they should be abandoned, and terms of diagnostic significance substituted—*e.g* cervical disc-lesion with root pressure, costal pressure on the lower trunk of the brachial plexus and so on. ' Neuritis ' and neuralgia ' are not suitable substitutes for "pain,' and if symptoms, because they radiate down the upper limb are therefore ascribed to neuritis, no diagnosis is arrived at nor does any indication on treatment emerge.

2 ' *Periarthritis*" *and Non-articular Rheumatism*

Presumably ' periarthritis" and ' non articular rheumatism can only mean that the tissues about a joint, rather than those forming it, are at fault. These words are also obsolete, they do not provide a diagnosis for they fail to answer the vital question—which of the periarticular structures is affected? After all each periarticular tissue has a name The terms, in short, though they sound impressive, are only evasions. At the shoulder the condition to which peri arthritis" is least ill suited is subdeltoid bursitis, which should be described as such Capsulitis ' provides an unexception able term for capsular contracture without irreversible struc tural change. Non articular rheumatism" at the shoulder might be used to describe any affection of the tendons or the sub-deltoid bursa Since clinical examination quickly differentiates between such lesions, they should be given their correct names.

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radiological grounds, been called "periarthritis" was a capsular lesion meriting the term arthritis, was finally proved by Nevasier (1945). He dissected post-mortem, or inspected at open operation, 63 shoulders at which limitation of movement was present on clinical examination He found that the capsule of the joint, instead of showing the normal laxity, was tight, closely applied to the head of the humerus and under such tension that it gaped widely when incised anteriorly. He found the densest adhesions between the two capsular

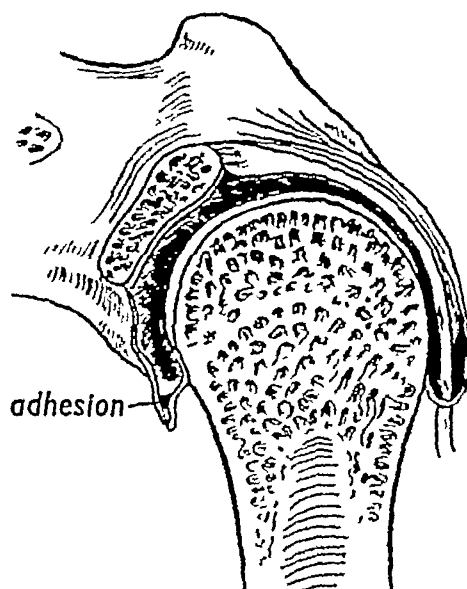


FIG 29.—Coronary section of the shoulder. A dense adhesion has formed at the inferior aspect of the joint, binding together the capsular fold (after Nevasier)

surfaces (see Fig. 29) to lie inferiorly, thereby limiting abduction. His conclusions were that the lesion was not a "periarthritis" at all, but thickening and contracture of the capsule which microscopy showed to be the site of reparative inflammatory change. He suggested "adhesive capsulitis" as a suitable term. These findings provide clear pathological confirmation of the views, then based on clinical considerations only, expressed in the original edition of this book. Viessel (1949) carried out arthrography with pyelosil on three cases of frozen shoulder and also found "a degree of obliteration of the inferior joint recess." J. H. Young confirmed this finding (1952) by post-mortem dissection.

8 *Periarthritis" and Coronary Disease*

Periarthritis" of one or both shoulders has been described as a complication of coronary disease. I have seen such cases occasionally but in my opinion there exists no relationship except in so far as an elderly man with recurrent pain at the left side of his chest becomes unwilling to move the painful part and thus ceases to use his left arm adequately This leads to stiffness, later to pain But so many patients with a stiff shoulder have not got coronary disease and so many with coronary disease fail to develop a stiff shoulder, that the occasional case is easily explained by coincidence.

By contrast, neoplasm of the lung does give rise to a con dition easily mistaken for arthritis Pectoral spasm limits abduction, but not rotation, hence the capsular pattern is absent (see p 202)

EXAMINATION OF THE SHOULDER

A full examination of the shoulder is difficult, partly because of the manifold movements that occur at the joint, partly because of the diversity of lesions that arise alone and in combination, and partly because of the difficulty in assessing exactly what weight to give to each response to a diagnostic movement. Palpation for tenderness is all but useless in the diagnosis of shoulder lesions, for many points about the head and neck of the humerus are normally very tender Tenderness can usually be found wherever it is sought and is, therefore, most deceptive. Indirect methods of singling out the structure at fault are thus essential and largely obviate the need for palpation, which is required only in subdeltoid bursitis and bicipital tendinitis

The acromio-clavicular joint must be examined with the shoulder Since every movement of the arm at its extreme affects the acromio-clavicular joint, it is a particularly fortunate circumstance that, lying so superficially pain arising here is accurately localized by the patient. Great confusion would result were the patient not clearly aware of the exact site of his pain Pain is referred as far as the lower deltoid region only when—rarely—the deep aspect of the joint is affected

TYPES OF EXAMINATION

Two kinds of examination are required at the shoulder-joint: one when active elevation of the arm is limited; the other when active elevation of the arm is of full range. Whether full elevation is painful or not is at this moment immaterial; the fact that it is *full* actively has the major significance and is the sole criterion in the present connexion.

The first step, therefore, in the examination of the shoulder is to ask the patient to raise his arm to its full height. If he cannot reach the normal limit, the examiner attempts full elevation passively. If this is also impossible, the existence of limitation of elevation at the shoulder-joint has been established. The examiner, keeping in mind that the scapula contributes 60° to the movement of elevation, compares the range of voluntary elevation (*i.e.* scapular rotation and humeral abduction combined) with the range of abduction obtained when movement at the glenohumeral joint is tested alone. To this end he fixes the lower angle of the scapula by placing his thumb against its outer edge and passively abducts the arm until he feels the scapula begin to move.

If limitation of movement at the shoulder is present, possible sites of the lesion are two, and further examination is simple. If full elevation cannot be reached actively but is possible passively the second type of examination is required, but the search is now for weakness of, not pain on, one or more resisted movements. When full elevation can be achieved actively, the possible lesions are many and examination of the whole forequarter has to be undertaken.

Since combined lesions are not uncommon at the shoulder the fact that there is limitation in every direction must not lead the examiner to omit trial of the resisted movements. A fall on the shoulder may, for example, damage the fifth cervical nerve-root as well as the joint; partial rupture of the supraspinatus tendon may set up a secondary subdeltoid bursitis; myopathy may result in capsular contracture from disuse, and so on. *Hence the resisted movements must be examined even in cases in which the discovery of limitation of range makes the diagnosis appear obvious.*

Normally, however, capsular lesions are uncomplicated and trial of the resisted movements does not set up pain or

show weakness. This fact provides clear evidence that, as at other joints, there is no primary lesion of the muscles in arthritis at the shoulder

THE RANGE OF MOVEMENT AT THE SHOULDER

The normal range of movement at the shoulder joint is a matter of dispute. Clearly the general belief—90° at the shoulder joint and 90° at the scapula—when the arm is moved

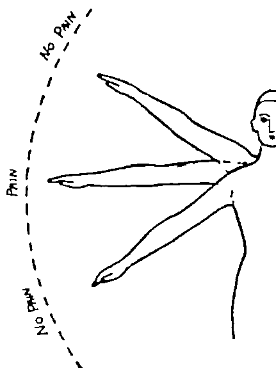


FIG. 80.—Painful arc at shoulder As the arm passes the horizontal, pain is elicited, disappearing as this point is passed in either direction.

from its dependent position to full elevation, is incorrect for inspection shows that the vertebral border of the scapula never lies horizontally when the patient s arm is held vertically upright. The actual mechanism is as follows from the adducted position to the horizontal position the arm moves at the scapulo-humeral joint. At 70° the greater tuberosity of the humerus is approaching the acromion, at 80° it lies immediately beneath and the head of the humerus moves slightly downwards as the tuberosity moves under the coraco-acromial ligament. At 90° the tuberosity has passed beyond



1.—Abduction at the shoulder-
; The scapula does not move
eciably. The humerus moves
ugh 90°, until the abduction
ement is stopped by engagement
ie greater tuberosity against the
of the glenoid fossa

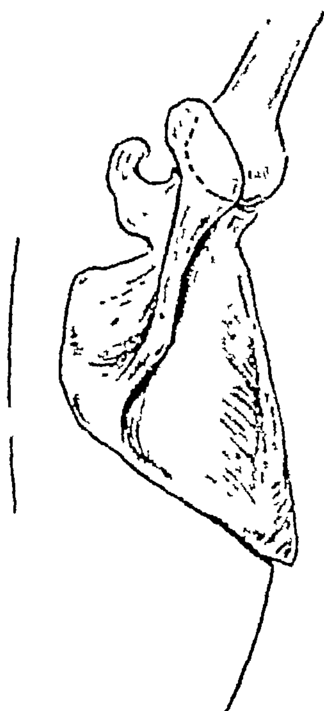


FIG 32—Scapular rotation. After the arm has reached the horizontal, the next 60° of elevation are brought about by active rotation of the scapula. This rotation brings the lower angle of the scapula antero-laterally with the result that the acromion and coracoid processes point vertically



FIG. 33—Final stage of elevation of arm. During the last 30° of elevation the scapula does not move. The neck of the humerus glides past the coraco-acromial arch by a movement of adduction, which ... carried out in th... ...deal instead of t... ...l plane on ac... rotation o...

the arch and engages against the upper edge of the glenoid labrum. This is how a painful arc comes about (see Fig 80)

The next 60° of elevation are performed by rotation of the scapula. In doing so the lower angle of the scapula moves well forward, and so tilts the whole bone that the coracoid and acromion processes lie pointing vertically (see Fig 82) At the same time the clavicle, being attached to the acromion, has to rotate also It possesses about 60° range of rotation at the sterno-clavicular joint. The last 30° of elevation now take place as the result of adduction of the humerus (see Fig 83), caused largely by contraction of the pectoralis major muscle. The coraco-acromial ligament no longer hinders the movement when the scapula has rotated fully, for the surgical neck of the humerus can now glide along it anteriorly

The range of rotation at the shoulder joint is 180°

Psychogenic Disorders at the Shoulder

The outstretched arm provides somatic evidence of welcome, by contrast, displeasure is evinced by withdrawal, characterized by the arm held in adduction Hence the shoulder joint is a common site for psychogenic symptoms In the detection of limitation of movement at the shoulder joint caused by psychogenic trouble, exact knowledge of the order in which movements take place at the shoulder is essential The patient has no idea of the sequence just described thus inconsistencies are quickly detected by the careful examiner When the limitation of active movement lacks organic basis, the range obtainable on passive movement while the scapula is held fixed by the examiner correlated with the strength of the abductor muscles when tested against resistance, at once reveals discrepancies

A malingerer, if middle-aged, who keeps his arm firmly to his side for some weeks, soon develops genuine limitation of movement at the shoulder This should be remembered when gross inconsistencies are found in conjunction with an immobilizational arthritis at the shoulder joint.

In recent traction fracture of the seventh cervical or first thoracic spinous process (clay shovellers) active abduction of either arm cannot be performed.

EXAMINATION IN CASES OF LIMITATION OF ELEVATION

The shoulder is the only joint in the body (with the possible exception of the elbow) at which limitation of movement in every direction does not necessarily indicate a capsular lesion; *for here this sign is found in affections both of the joint-capsule and of the subdeltoid bursa.* Differential diagnosis between a capsular and a bursal lesion at the shoulder-joint is thus necessary, since the prognosis and treatment are quite different, and depends on the discovery of the relationship borne by the degree of limitation of abduction to the degree of limitation found when rotation is tested. Hence, if passive abduction is found restricted, the amount of rotation obtainable passively in each direction is ascertained The pattern that emerges is capsular or non-capsular.

The Capsular Pattern

The relationship is as follows: lateral rotation the most limited, abduction intermediate, medial rotation the least limited. For example, 45° limitation of abduction corresponds to 60° limitation of lateral rotation and 15° limitation of medial rotation. Doubt may exist whether a slight degree of limitation of elevation is present or not; if so the discovery of a full rotation range strongly suggests that elevation is also full. This is of importance in the distinction between the slight general limitation due to an early capsular lesion and the pain on full passive elevation due to a supraspinatus tendinitis as the tender tendon is squeezed between the greater tuberosity and the glenoid rim. In the latter case, but not in the former, passive rotation in each direction is full and painless.

The range of *lateral* rotation, though always more limited in arthritis than that of medial rotation, is less easily estimated. Most individuals can put the forearm in the coronal plane with the elbow held into the side. Fifteen degrees limitation of *medial* rotation prevents a patient from putting his hand behind his back. This is most obvious to any examiner. Such an amount of limitation of medial rotation is usually associated with 60° limitation of lateral rotation, and the two sides must be compared. Examination of the passive move-

ments must be thorough enough to disclose this type of relationship, for the first pointer to the fact that the patient is suffering from acute subdeltoid bursitis or a pulmonary neoplasm and not from arthritis is often provided by the absence of the pattern proper to a capsular lesion

The distinction between a capsular lesion and acute bursitis rests on the following factors.

Acute Subdeltoid Bursitis

The bursa exists to provide two gliding surfaces that enable the greater tuberosity to slip smoothly under the acromion otherwise the two projections would catch against each other It has two parts subacromial and subdeltoid The subacromial part covers the superior aspect of the supraspinatus and infraspinatus tendons, extending medially as far as the acromio-clavicular joint line. The subdeltoid part reaches about an inch below the greater tuberosity covering the entire outer aspect of the uppermost part of the humerus

1 *Non-capsular Pattern* In acute bursitis 60 limitation of abduction is usually associated with little or even no limitation of either rotation, merely pain at extremes When such limitation of abduction is present, the characteristic painful arc cannot be elicited hence lack of the normal articular correspondence provides a physical sign of the first importance.

2 *No Muscle Spasm* The second distinguishing feature is that, the joint not being involved, the range is limited by the patient's declaring that he cannot, because of increasing pain, allow further movement, there is no muscle spasm at all In the end if the examiner continues to move the joint further, the patient voluntarily brings his arm down again by using his own muscles, this takes place at a variable point, depending upon how much he will let himself be hurt at any particular moment On the other hand in a capsular lesion, however often the movement is attempted muscle spasm springs into being at the same definite point and no amount of forcing without anæsthesia avails to increase the range

3 *Swift Onset.* A third distinguishing feature is the speed of the onset. A patient who without injury in the course of two or three days loses almost all capacity to abduct the

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3 *Swift Onset.* A third distinguishing feature is the speed of the onset. A patient who without injury in the course of two or three days loses almost all capacity to abduct the

arm is almost certain to be suffering from acute subdeltoid bursitis. Plate 9 shows such a case. Recurrent attacks are not uncommon, usually at intervals of several years.

4. *Disproportionately Limited Abduction.* A fourth feature is the fact that the range of active abduction may be limited to, say, 10° at a time when the passive range in this direction is, say, 30° or even 45°. Apparently the abductor muscles, on account of their intimate relationship to the bursa, are inhibited from any but slight contraction in the acute stage. Unless this fact is kept in mind, severe bursitis may be mistaken for a psychogenic disorder.

5. *Palpation.* Palpation for tenderness and the source of crepitus (if any) follows. In acute subdeltoid bursitis, the tenderness is very obvious when the two sides are compared. Exceptionally, unilateral thickening of the bursal wall may be felt, and even less often fluctuation may be detected. If so, aspiration shows whether blood or clear fluid is present.

6. *Painful Arc.* In acute bursitis, this valuable sign is lacking, but as the patient recovers his range of abduction, the painful arc eventually appears, thus confirming the diagnosis.

Sub-coracoid Bursitis

Diagnosis is difficult. There is nothing distinctive about the pain which is felt at the deltoid area, only on movement. One characteristic pattern is full range in every direction except lateral rotation at the shoulder which is 30° to 45° limited, when tested with the arm by the side. The fact that this is not caused by anterior capsular contracture is demonstrated by lateral rotation being found full when this movement is tested with the arm horizontal. Clearly a space occupying lesion exists extra-articularly at the front of the shoulder-joint. If local anæsthesia confirms this hypothesis, hydrocortisone should be injected at the lateral aspect of the base of the coracoid process.

A less obvious pattern is presented by the patient whose only painful movements are full passive elevation and full passive adduction (across the front of the chest) of the arm, associated with absence of pain on resisted medial rotation. The same treatment applies.

CAPSULAR LESIONS

When limitation of movement corresponding to the capsular pattern has been demonstrated the following points must be considered It should be remembered that capsular lesions are the commonest cause of stiffness at the shoulder at all ages, and almost the only cause in elderly people Capsular lesions unlike bursitis may not be self limiting

The age of the patient is significant, since minor trauma is often followed by a capsular lesion in the elderly The presence of osteo-arthritis makes the joint very apt to develop a traumatic arthritis after only slight jarring or some overuse Crepitus is palpable, and results from erosion of cartilage at the glenoid fossa. Freezing arthritis comes as a rule between the ages of forty five and fifty five. Mon articular infective arthritis can come on at any time after the age of twenty five

Muscular wasting never occurs in subdeltoid bursitis or in traumatic freezing and osteo-arthritis, some may be detectable, especially in the deltoid and spinatus muscles, in infective arthritis great wasting indicates a specific arthritis, e.g tuberculous, or neoplasm. Limitation of every movement by a painless *bony block* characterizes a neuropathic arthropathy, or displacement of a fractured tuberosity under the acromion

The different types of capsular lesion require differentiation for prognosis and treatment vary with the disorder present.

VARIETIES OF CAPSULAR LESIONS

The following disorders are characterized by limitation of movement at the shoulder joint of the capsular pattern without pain when the resisted movements are tested

1 *Traumatic Capsulitis*

There is a history of trauma. In young patients the injury is severe but after middle age quite slight jarring of the joint suffices to set up the train of events that leads to capsular contracture

After a direct injury there is of course immediate pain If fracture or dislocation has not occurred, the pain eases after

4. *Freezing Arthritis*

This is a remarkable phenomenon, without parallel at any other joint. Freezing arthritis usually comes on between the ages of forty-five and fifty-five. It follows, with only slight variations between one individual and another, a fixed course. Freezing arthritis is a good descriptive label; for after freezing, the joint then thaws

For no apparent reason, a middle-aged patient begins to feel an ache at the shoulder on moving the arm. There is no pain when the arm is kept still. At this time examination reveals almost a full range of movement at the shoulder-joint, each extreme hurting when tested passively; the resisted movements prove painless. After a month or two, the pain on movement becomes more severe and spreads as far as the elbow; a constant aching sets in, worse at night and worse still if the patient lies on that side in bed. Limitation of movement at the shoulder-joint of the capsular type is now clearly apparent. At the end of two or three months the pain has become constant and severe, reaching to the wrist. Severe pain on the slightest jarring of the joint may compel the patient to wear a sling. Examination now shows an abduction range of only 30° to 45° with corresponding limitation of rotation. The shoulder, however, never becomes strictly speaking " frozen "; for complete fixation of the scapulo-humeral joint (such may occur in infective arthritis) is absent. No further diminution in the range of movement takes place after four months.

At the end of four months the pain begins to ease and at the end of six months the constant ache has largely ceased. Once more pain is felt only when the shoulder is moved and it leaves the forearm, remaining only in the arm. He begins to be able to lie on that side again at night. Later still, the pain produced by movement becomes confined to the deltoid area and the range of movement begins to return to the joint At the end of ten to sixteen months the patient is well; the ache has ceased and he has regained a full range of movement at the shoulder.

There is little deviation in untreated cases from this standard course of four months' deterioration, four months of a stationary range of movement but lessening pain, and four



PLATE 10

Calcification in the supraspinatus tendon. The clinical signs of tendinitis were present.



PLATE 11

Vertical disc-protrusion. In a woman of 68 osteoporosis had led to herniation of disc-substance into the body of the twelfth thoracic vertebra. There were no symptoms.



PLATE 12

Adolescent osteochondritis The patient was a girl aged 14 with a history of six months' mid-lumbar backache Note the anterior defect at the bodies of the second and third lumbar vertebræ, causing wedging at the affected levels The symptoms were caused by a reducible disc-lesion, secondary to the articular deformity

months' restoration of range The only measure that alters this routine is mobilization of the joint under anæsthesia during the first stage, which leads to one to three months' aggravation and postpones spontaneous cure by that length of time The fact that freezing arthritis is not, as has been widely supposed, a pure degeneration is shown firstly by the fact of spontaneous cure and secondly by its rarity after the age of sixty

Examination throughout shows the capsular pattern in its various degrees the resisted movements remain strong and painless.

5 *Infective Arthritis*

Infective arthritis (*i.e* mon articular rheumatoid) starts in exactly the same way as freezing arthritis At first they can scarcely be distinguished clinically The radiograph and estimating the blood sedimentation rate afford no assistance. Nevertheless differentiation is most important, for infective arthritis responds dramatically to hydrocortisone whereas on freezing arthritis this has no effect.

In either case, unprovoked pain begins at the upper arm and spreads in due course down the limb, and examination shows limitation of movement in the capsular proportions

There are certain considerations that suggest infective rather than freezing arthritis

(*a*) *The Patient's Age* Freezing arthritis seldom starts before the age of forty five and probably never before forty If the patient is in his twenties or thirties, little doubt exists, therefore.

(*b*) *Paræsthesiæ* Rheumatoid perineuritis may accom pany the infective arthritis Hence pins and needles in the affected limb coming on just before or at the onset of the arthritis provides a strong pointer, as long as no alternative cause for the pins and needles is discoverable

(*c*) *Chronology* Freezing arthritis follows a predictable course infective, not. During four months the pain of freezing arthritis gets slowly worse During the first month the arm aches only on movement at the shoulder at the end of two months constant ache reaches the elbow after three or four months the pain is considerable all the way down to

the wrist. After a month adduction is 10° limited; after two months 30° limited; after three or four months 45° to 60° limited. The last 30° of abduction are not lost. Hence a range of movement much too great or much too small for the length of time that the condition has lasted suggests infective arthritis.

Recovery follows an equally constant course in freezing arthritis At the sixth month the pain has largely eased and at the eighth month there is no pain except on forcing the joint Now the range begins to increase, until spontaneous restoration is complete at the end of the year Infective arthritis by contrast may go on getting worse until permanent fibrous ankylosis is complete, or after a year or two, may improve somewhat or even get quite well But it may flare again later, whereas I have never met with recurrence of a freezing arthritis at the same shoulder Infective arthritis often attacks both shoulders, simultaneously or concurrently, whereas bilateral freezing arthritis is a great rarity, though it may affect the other shoulder some years later I have known infective arthritis to start at the age of twenty and continue, flaring and settling down at intervals, for thirty years, by which time there was an abduction range of 60° at one and 10° at the other shoulder Another patient, now aged forty-five, has had an unvarying 60° range of abduction at one shoulder for twenty years Such a shoulder is often all but painless except on exertion.

In spondylitis deformans one or both shoulder-joints are sometimes affected, usually not severely, and the joint may recover after a year or so The shoulder may become affected in multiple rheumatoid arthritis, in gonorrhœa or in osteitis deformans.

(*d*) *Wasted Deltoid* Freezing arthritis is not a grave enough disorder to cause visible wasting of the deltoid muscle. It is difficult to be certain of wasting, especially when the left shoulder is affected in a right-handed patient; nevertheless its presence is a sure sign of infective arthritis.

If all these findings are carefully assessed, a diagnosis is usually possible. If real doubt still exists, a therapeutic test injection into the joint of 25 mgr. hydrocortisone has settled the question by two days later.

conforming to any one neurological lesion nor being confined to any one muscle. X-ray examination is confirmative.

Localized warmth felt at part of the scapular area may prove the first sign of a malignant deposit eroding bone. Within at most a week or two of this finding a palpable tumour will have appeared and erosion of bone will be visible on the radiograph.

10. *Primary Neoplasm*

This occurs chiefly in young patients, in whom causeless limitation of movement at the shoulder should lead at once to study of the radiographic appearances. If the tumour originates from the shaft of the humerus the first symptom may be pins and needles in the hand associated with fixation of the biceps and triceps muscles, leading to limitation of movement at the elbow. Chronic afebrile osteomyelitis and sarcoma are sometimes indistinguishable radiologically; biopsy or the response to penicillin may then be required to establish the diagnosis.

11. *Neoplasm of Lung*

When a pulmonary neoplasm is situated towards the apex of the lung, invasion of the lateral extent of the ribs leads to reflex spasm of the adductor muscles of the shoulder. Hence abduction of the arm becomes markedly limited whereas rotation remains of adequate range—a non-capsular pattern. Simultaneous invasion of the axilla affects the muscles controlling the shoulder and elbow, which are found not only weak, but their contraction provokes pain as well. The radiograph of the shoulder-joint reveals no change, but that of the lung shows the pulmonary opacity

12. *Acromio-clavicular Joint*

At the extreme of each passive movement at the shoulder, the acromio-clavicular joint is stretched. Patients with a disorder at the shoulder-joint complain of an extent of pain in the arm, whereas disorders of the acromio-clavicular joint give rise to purely local symptoms. Thus pain con-

fined to the point of the shoulder elicited by the passive shoulder movements, associated with a full range of movement at the shoulder joint, draws attention to the acromio clavicular joint. The resisted movements are all found painless (see p 220)

THE RADIOGRAPH

There are few joints where the radiographic appearances afford as little assistance as at the shoulder Usually nothing abnormal is seen, even after the shoulder has been the site of months of severe arthritis. Subdeltoid bursitis and traumatic capsulitis, no matter how long standing rarely give rise to radiographic change. Infective arthritis is often associated, at first, with a normal picture, later slight general decalcification may be seen. Osteophyte formation is seldom visible and, when it is, may be symptomless Huge osteophytes may limit movement, at times all but painlessly It should not be forgotten that, for example, osteophyte formation at the shoulder does not protect a patient against a tendinous lesion, to which all the symptoms may be attributable.

Calcification may appear in the subdeltoid bursa, but even a large area of calcification of the bursa is consistent with full and painless function at the shoulder joint, by contrast, many cases of bursitis display no calcification. Small calcified nodes may be seen at various places, most often in the supraspinatus tendon, but do not usually cause symptoms, on the other hand, large deposits in the tendon do cause pain, both at the arc and on active abduction (see Plates 9 and 10)

Deposits should be regarded as significant only when they correspond in situation with the lesion already determined by clinical examination. Tuberculosis, neuropathic arthropathy primary and secondary neoplasm, dislocation, fracture, osteoma, bone abscess, chondromatosis, osteitis deformans—it is conditions like these that show on the radiograph, whereas all the common causes of pain arising at the shoulder fail to show on the x ray plate. Hence radiography provides no short cut to diagnosis. This depends wholly on adequate clinical examination of the joint.

CLINICAL STAGES OF CAPSULAR LESIONS

The division of capsular lesions at the shoulder into acute, subacute and chronic has proved unsatisfactory, in so far as these words can be used equally well to describe how recent or how severe the lesion is. It so happens that, soon after an injury, the capsulitis is acute in the sense that it is recent, but chronic in the sense that the lesion is not yet severe and responds well to active treatment. Equally, after some months, the inflammation may become acute, *i e.* severe, when the passage of time clearly warrants the designation chronic. This nomenclature has, therefore, been abandoned and the stages merely numbered. Severe, moderate and mild are not satisfactory alternative qualifications; for a lesion leading to little pain but marked limitation of movement at the shoulder clearly cannot be termed " mild " even though, like a recent capsulitis associated with little restriction of range, it responds well to active treatment

First Stage of Capsular Lesions

When the following criteria are satisfied, the arthritis, whether of recent onset or long-standing, is in a stage suitable for active treatment.

1. When the pain is confined to the deltoid area or at least does not extend beyond the elbow.
2. When the patient can lie on the affected side at night.
3. When there is no pain except on movement.
4. When there is a stationary range of movement at the shoulder-joint.

When, as occasionally happens, these criteria are satisfied only in part, the capsulitis may be assumed to be in the second stage. For example, a patient may have pain confined to the shoulder and yet be unable to lie on the affected side at night

Third Stage of Capsular Lesions

When the following criteria are satisfied, the arthritis is in the stage when all active measures directed to the joint

the arm to the wrist; after a few days, it becomes severe and constant. The patient's sleep is now much disturbed, and he soon finds that he can barely move his arm at all After five to seven days of severe pain, the symptoms abate somewhat; at the end of two or three weeks there remains only an ache, and active movement may have reached half-range. At the end of four to six weeks the patient has fully recovered. When he is nearly well the painful arc appears again for a week or so.

2. *Localized Bursitis*

The onset is usually gradual and apparently causeless; there are no acute episodes. Examination reveals a full and painless range of movement but a markedly painful arc. This finding, associated with complete freedom from pain on any resisted movement, is pathognomonic of local tenderness of the subdeltoid bursa Rarely, localized bursitis follows a direct injury. Some thickening of the bursal wall may be detectable; rarely a small effusion of clear fluid occurs.

The point at which the arc begins affords a pointer to whereabouts the affected area lies. The earlier it starts, the higher up the lesion lies. If the arc begins to be felt at, say, 45° of abduction, the upper part of the bursa close to the acromion is affected. An arc starting at 80°, *i e.* just before the arm reaches the horizontal, can be interpreted in two ways as signifying either that the lesion lies at the lower edge of the bursa, or that it involves the part of the bursa out of fingers' reach, *i.e.* the part covered by the acromion. If careful palpation does not reveal any tenderness of the accessible part of the bursa, the second alternative should be considered. Local anæsthesia is always required to confirm what is always a tentative localization; moreover, it happens to be the only effective treatment.

Localized bursitis goes on for years in many cases, continuing until the exact spot is found and injected. It has none of the self-limitation of acute bursitis. It is commonest in women aged thirty to sixty. The radiograph nearly always reveals nothing.

Spontaneous painless effusion into the bursa may, as happens at other joints, complicate severe rheumatoid arthritis;

doubtless it would give rise to a painful arc if the arthritis at the shoulder did not prevent movement to that point.

3 *Subdeltoid Bursitis with Calcified Deposit*

Judging by the literature, calcification of the bursa occurs less often in England than in the U.S.A and when it is met with in this country, the patient is often of mid European descent.

The onset is sudden and unprovoked Within a few days the patient finds himself unable to move the arm appreciably because of severe pain spreading from the shoulder to forearm and wrist. The pattern of limitation is non-capsular (see p 202) the bursa is very tender and the radiograph reveals calcification in an area about 2 cm across there is often a smaller similar shadow at the other (symptomless) shoulder It is my belief that a further deposition of salts has taken place. The disorder recovers more quickly than acute bursitis without a deposit the patient is usually quite well in three weeks though the calcification remains, sometimes disappearing spontaneously after several years The sequence of events is so similar to that in gout that blood uric-acid estimations were carried out in a small series of cases However the highest figure obtained was 4·0 mg and some were low normal levels (under 2 0 mg)

4 *Hæmorrhage into the Subdeltoid Bursa*

In my experience this has occurred only in old age. The hæmorrhage has apparently been spontaneous in all cases except one in which the bleeding was secondary to rupture of the supraspinatus tendon. The complaint is of swelling and pain. Visible bruising is occasionally present. The bursa is prominent and tense, fluctuation is easily detectable Aspiration reveals blood In long-standing cases fibrous clots can be felt to move about inside the bursa.

The range of movement is found limited more by the bulk of the fluid than by the bursitis, it is slight, but after a period of disuse owing to pain, greater limitation due to capsular contracture may well supervene. Recurrent hæmorrhage into the bursa after aspiration suggests hæmangioma

5. *Crepitating Bursitis*

Patients are seen, usually a year or two after a subdeltoid bursitis with effusion has subsided, complaining of creaking at the bursa on moving the arm and some aching in the deltoid area after exertion. (No treatment appears to make any difference, but the disability is very minor.)

6. *Incomprehensible Bursitis*

Patients are rarely encountered who have pain felt at the shoulder coming on only during, and for some hours after, considerable exertion. They can carry on in spite of the pain, which is disagreeable but not disabling, and goes on for years.

Examination shows one of four patterns.

1. Full range; both passive rotations hurt; full elevation is painless, there is no arc, the resisted movements do not hurt

2. Full range with discomfort at extremes; painful arc; resisted abduction and lateral rotation both hurt.

3. A changing pattern of pain on resisted movement. Full painful range of passive movement The resisted movements hurt in an erratic way, the response being pain then not when the test is repeated. Slight arc.

4. Slight limitation of passive abduction alone or passive medial rotation alone. The resisted movements are painless or all equally painful. No arc.

I am at a loss to explain how these signs signify bursitis, but the fact remains that infiltration of the affected area of the subdeltoid bursa is immediately curative after every other treatment tried by me (and others) has failed. If no part of the subdeltoid bursa is found tender, local anæsthesia has to be induced subcromially until the right spot is found.

CHAPTER X

THE SHOULDER

PART II: FULL RANGE

THE causes of limitation of movement at the shoulder are dealt with in Chapter IX. The presence of a full range of movement at the shoulder shows arthritis and acute bursitis to be absent. The source of the pain felt by the patient in what he calls the shoulder is then most indeterminate and, if errors are to be avoided, it is necessary briefly to examine the neck and entire forequarter Attention should be paid both to pain produced by each particular movement and to weakness

EXAMINATION

FIRST STAGE

This is a negative examination, to exclude pain which appears to originate from the vicinity of the shoulder but in fact arises in the neck or upper limb below the shoulder It should be borne in mind in this connexion that patients hold widely different views on the point where the neck becomes the shoulder thus the patient should be asked to point out the site of his 'shoulder" pain The fact should then be established that the symptoms do not arise from the tissues about, or controlling, joints other than the shoulder

To this end the patient is asked to perform movements at the neck elbow, wrist, thumb and fingers, equal attention being paid to the elicitation of weakness as of pain.

It should be remembered that lesions of the diaphragm may set up pain felt in the shoulder and upper arm, brought on by deep breathing and coughing Finally it must not be forgotten that myocardial pain may be felt in one or both upper limbs, without the appearance of any pain in the chest. In such a case exertion unconnected with use of the arm (e.g walking upstairs) brings on the symptoms and examination of the upper limb reveals no abnormality

SECOND STAGE

If the examination detailed above suggests that the pain does not arise in the vicinity of the other joints contained within the lower cervical segments, the resisted movements at the shoulder should be tested one by one. The movements to be tested against resistance are abduction, adduction, lateral rotation, medial rotation at the shoulder, followed by flexion and extension of the elbow. Care should be taken to have the patient's arm near the mid-position and to resist the contraction so strongly that no actual movement takes place. It should be realized that the patient puts the flexor muscles of the elbow into active use when resisted rotation movements are examined in the manner advocated below; thus, pain felt in the upper arm on both resisted medial and lateral rotation may arise from the biceps muscle, particularly its long head.

Lesions simultaneously affecting every muscle about the shoulder-joint do not, in my experience, occur; the fact that every resisted movement hurts may therefore be ascribable to the fact that the spinal joints have to be fixed before any strong shoulder movement can be attempted; this finding thus suggests the source of the pain to lie at the neck or upper thorax. Alternatively, there may be constant pain to which the patient refers each time, since he fails to realize that the question is one of aggravation by movement. Renewed explanation is, therefore, required if the patient's responses fail to conform to any of the known patterns. When pain on passive movements accompanies pain on all the resisted movements, the question of psychogenic or assumed disability also comes very much to the fore.

In the first place, resisted abduction, adduction, medial and lateral rotation are tested. Whether or not one movement proves painful or weak, each of the others should be tried for the reason adduced above—that response to pain produced by one resisted movement can be regarded as significant only if others are stated not to hurt. If a movement hurts, a group of muscles is thereby incriminated; various subsidiary movements are then tested to show which individual of that group is at fault. The movements may be tried in any order, but they must *all* be tried.

Resisted Abduction Movement

The term 'abduction" cannot be properly applied to positions of the arm after it has passed the horizontal and, to avoid ambiguity will be reserved for movement away from the body below the horizontal Above this line, the word 'elevation" will be substituted The movement is resisted by

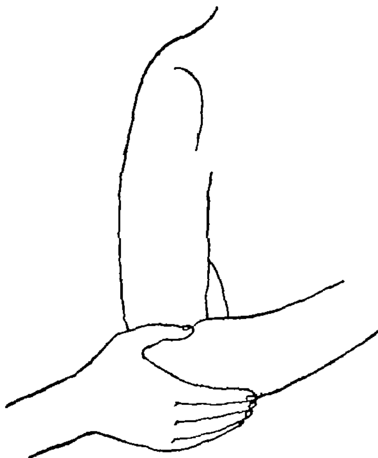


FIG 34.—Resisted abduction of arm. The patient pushes his elbow away from his side while the examiner's hand resists the movement so strongly that none takes place.

the examiner s hand placed at the outer aspect of the patient's elbow (see Fig 34)

In theory, pain on a resisted abduction movement can arise from the supraspinatus or the deltoid muscle. Apart from direct injury, complete recovery from which is usually swift, lesions of the deltoid muscle rarely occur Hence pain on the resisted movement towards abduction as good as

incriminates the supraspinatus muscle. In order to be quite sure, the patient is asked to bring his arm to the horizontal position and a forward and backward movement is resisted. This elicits pain from the anterior and posterior fibres of the deltoid muscle in turn If, as is to be expected, neither of these movements hurts, the fault lies with the supraspinatus muscle.

The position of the lesion within the supraspinatus muscle is next identified as follows (see Fig. 35):

1. A painful arc exists. This shows the lesion to lie superficially near the teno-periosteal junction, just medial to the greater tuberosity of the humerus. Should the painful

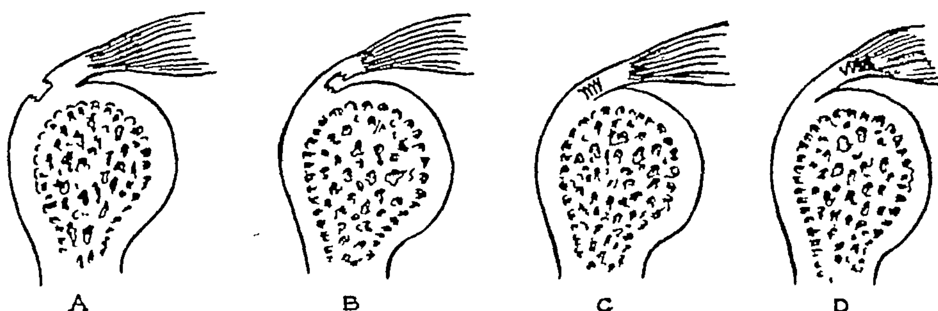


FIG 35—Supraspinatus tendinitis Accessory signs indicate the exact position of the lesion

A Painful arc The lesion lies superficially at the teno-periosteal junction
B Pain on full passive elevation The lesion lies deeply at the teno-periosteal junction
C. Both a painful arc and pain on full passive elevation The lesion traverses the distal end of the tendon
D Neither an arc nor pain on full passive elevation The lesion lies at the musculo-tendinous junction

arc prove more marked when the abduction movement is carried out in medial than in lateral rotation of the arm (*i.e.* palm down or palm up) additional information is afforded. If the arc is more marked when the arm is brought up palm upwards, the lesion lies at the anterior aspect of the teno-periosteal junction; if palm downwards hurts more, the posterior part of the tendinous insertion is singled out. These accessory localizing signs are particularly useful when hydrocortisone is to be injected.

Of course the mere presence of a painful arc exculpates the deltoid muscle.

2. Full passive elevation of the arm hurts. This implies tenderness of that part of the tendon which engages against

the glenoid rim i.e the deep aspect at the teno-periosteal junction If this sign is found together with a painful arc, the lesion clearly traverses the distal end of the whole tendon

3 The absence of a painful arc and of pain elicited on full passive elevation naturally suggests a lesion of the supra spinatus at the musculo-tendinous junction, since the belly itself is very rarely affected. Tenderness of the musculo-tendinous junction may be sought, and the two sides compared, deeply within the angle formed by the clavicle and the spine of the scapula. However, local anæsthesia should always be used to verify this diagnosis for an occasional case of tendinitis at the teno-periosteal junction unexpectedly fails to show either of the two localizing signs (Rupture of the supraspinatus tendon is dealt with on p 236)

In spite of the intimate relation of the supraspinatus tendon and the subdeltoid bursa, a resisted abduction movement, when properly tested, is painless in even acute bursitis.

Resisted Adduction Movement

The arm is brought a short distance away from the body and the adduction movement resisted by pressure exerted against the inner side of the elbow (see Fig 80) The muscles responsible are the pectoralis major, the latissimus dorsi and the two teres Pain except when it arises from the axillary portions of the pectoralis major or latissimus dorsi muscles, is usually correctly appreciated by the patient at the anterior or postero-lateral aspects of the thorax respectively When the patient s sensations are no guide and an adduction movement hurts, the next part of the examination is to ask him to swing his arm first forwards then backwards against resistance. If the former hurts, the pectoral muscle is at fault and confirmation may be sought by asking him to press his hands together as in Fig 87 If the backward movement hurts, the fault lies in one of the other three muscles The teres muscles may be differentiated by the fact that the major is a medial, the minor a lateral, rotator of the humerus The latissimus dorsi and teres major muscles being identical in function no test distinguishes between them In fracture of an upper rib anteriorly testing the pectoralis major muscle naturally hurts

FIG 36.—Resisted adduction of arm The patient draws his elbow to his side The examiner resists the movement, steadying the patient's trunk by one hand on his hip.

FIG. 37.—Resisted horizontal adduction of arms The patient is pressing his palms together. Pain arising from the pectoralis major muscle is most easily elicited in this way.

Palpation follows when the pectoralis major muscle is affected, the fibres just below the lateral half of the clavicle or those at the lower extent of the outer edge being the common sites The lesion in the latissimus dorsi muscle is usually found at the upper part of the outer edge

Resisted Lateral Rotation Movement

The patient's arm must be kept at his side with the elbow held at a right angle and the movement resisted by pressure applied just above the wrist (see Fig 38) If the pressure is

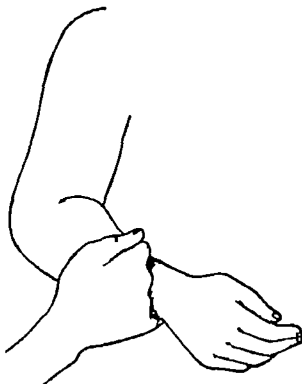


FIG 38—Resisted lateral rotation of arm. Keeping his elbow at his side, the patient pushes his wrist away from his body Note that the examiner's hand is placed at the lower forearm avoiding pressure on the patient's hand. The patient's forearm is supported by the examiner's fifth finger No outward movement is allowed to occur

applied at the hand the response to resisted wrist movements complicates the picture. Patients are very apt to abduct the arm when asked to rotate it outwards, this must be guarded against, otherwise a supraspinatus tendinitis may be mistaken for an infraspinatus tendinitis If resisted lateral rotation alone hurts, an infraspinatus tendinitis is present. If a

resisted adduction movement also hurts—which is very uncommon—the teres minor muscle is inculpated. A painful arc *on elevation* (see Figs. 30 and 40) often occurs with infraspinatus tendinitis; in this condition there are occasionally two arcs, *i.e.*, pain coming on just before the arm reaches the horizontal position and again just above this point with a painless interval between them of five or ten degrees.

The presence of a painful arc singles out the teno-periosteal junction of the infraspinatus muscle as the site of the lesion; in its absence there is no way of telling which part of the tendon is affected except by palpation for tenderness and by observing which part of the tendon has to be given massage in order to diminish the tendinitis. In cases without an arc there is thus a good deal of trial and error in finding the exact site of an infraspinatus tendinitis; an experienced physiotherapist is invaluable in this connexion. Local anæsthesia affords little help, for one cannot tell within a quarter of an inch where the liquid has been placed. In rupture of the infraspinatus tendon, the weakness is very noticeable.

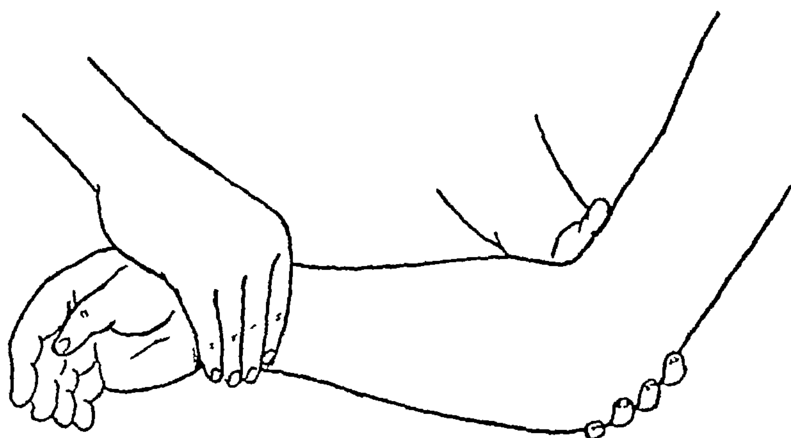


FIG 39—Resisted medial rotation of arm. The patient pulls his forearm towards his trunk. The examiner steadies his elbow and resists the movement by pressure against his wrist

Resisted Medial Rotation Movement

This movement (see Fig. 39) provides information about pain arising from the subscapularis, pectoralis major, latissimus dorsi and teres major muscles. The last-named three

muscles are all adductors, whereas the subscapularis muscle is a weak abductor It suffices, therefore, to show the absence of pain on a resisted adduction movement to demonstrate that the subscapularis is the muscle affected If a lesion of this muscle has thus been shown to exist, two further localizing signs should be sought. (1) A painful arc. If this is present, the lesion can be confidently ascribed to the uppermost part of the teno-periosteal junction, since only the top of the lesser tuberosity can engage against the coraco-acromial arch (2) Pain on passive adduction across the front of the chest. At the extreme of this movement the lesser tuberosity is squeezed against the coracoid process. This shows the lesion in the tendon to lie in its humeral insertion at its lower extent. Lesions in the subscapular belly appear not to occur, complete rupture of the tendon is rare and leads to great weakness on resisted medial rotation.

Resisted Forward Movement

When pain is elicited by this movement alone, the lesion has on each occasion been found to lie at the upper extremity of the coraco-brachialis muscle In theory resisted adduction should also have hurt, in practice it has not done so.

Resisted Flexion and Supination at the Elbow

Pain brought on at the shoulder by these movements clearly arises from the biceps muscle This diagnosis is confirmed by finding that all the passive and resisted movements at the shoulder itself are painless. The tendon of the long head of biceps is always affected I have yet to meet a lesion at the short head. Unless, as is rare, a painful arc exists, there is no way of finding out which part of the long tendon is affected except on palpation for local tenderness.

A snapping long head seldom causes clinical tendinitis.

THIRD STAGE

Whenever possible, all diagnoses based on the discovery of which movements prove painful, and of tenderness of the structure thus outlined, should be confirmed by local anæsthesia

Indeed, it is by trial and error over the past fifteen years at I have taught myself the proper interpretation of these nilar but not identical patterns, and have been able to olve methods of effective treatment. I therefore commend ıgnostic local anæsthesia at the shoulder to all those who ıuld follow in these footsteps, at any rate for the first five ars of the attempt.

PAINFUL ARC OF MOVEMENT

Since the bones themselves are seldom at fault, this finding ually implies that tenderness exists of a structure lying tween the humerus and the acromion; the lesion is pinched ıen the prominent tuberosity passes under the arch, *i.e.* at ° of abduction (see Fig. 40) The pain is elicited better

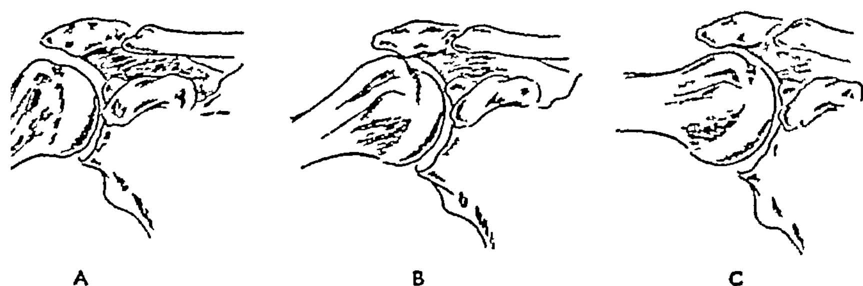


FIG 40—The mechanism of a painful arc at the shoulder

Vo pain At 70° of abduction the humeral tuberosity is approaching the acromion As yet no pain is felt.
Pain At 80° of abduction the tuberosity lies under the acromion If a tender structure lies between two bones, it is now painfully squeezed
Vo pain At 90° of abduction the tuberosity has passed the acromion and the painful pinching ceases

active than on passive movement. Since the pain is due engagement of one or other tuberosity against the coraco-omial arch, it is greatest when the abductor muscles are ıtracting and the head of the humerus is held well lodged ınst the arch. Once the arm has passed beyond the ·izontal in either direction the pain ceases abruptly. A nful arc can usually be obviated by bringing the arm up wards instead of outwards. Many patients have learnt s for themselves and may be seen, as the proposed move-nt reaches the horizontal, to bring the arm forward and ate it outward so as to minimize the painful pressure.

Sometimes the painful arc appears solely on the upward, less often only on the downward, passage of the arm. Rarely there is a painful arc on rotation of the arm.

The occurrence of a painful arc nearly always means that a structure lying between the acromion and one or other humeral tuberosity is tender It is only rarely that the inferior aspect of the arch itself is tender, as the result of a severe sprain at the deep fibres of the acromio-clavicular joint, or rarely, malignant invasion of the acromion. The possible causes of a painful arc are thus as follows

1 LESIONS OF THE SUPRASPINATUS TENDON

These are by far the commonest cause of this phenomenon, which implies tenderness at or very near the greater tuberosity either from trauma to calcification in, or rupture of the supraspinatus tendon In the first case, the power of abduction is full and this movement is painful when resisted The radiograph reveals nothing In the last (see p 236) the power of initiating abduction is lost and the presence of a painful arc discoverable only on a passive elevation movement, the radiograph is normal Calcification is of course clearly visible radiographically (see Plate 10)

2 SUBDELTOID BURSITIS

If this causes a painful arc, the bursitis is localized for in acute bursitis pain prevents the tuberosities from being pushed past the arc and limitation of abduction results. A part of the bursa can remain tender for years In such cases, there is a painful arc, but the extreme of each movement is painless, and none of the resisted movements hurts —in other words there is *only* an arc. This finding differentiates mild chronic bursitis from lesions of the supraspinatus, infraspinatus or subscapular tendon, all of which are characterized by pain elicited by the appropriate resisted movement. Many authorities regard bursitis and tendinitis at the shoulder as identical or, at least, indistinguishable This is by no means so if the examiner takes the trouble to test these resisted movements. Part of the bursa is sometimes calcified (see Plate 9)

Since the treatment of bursitis is local anæsthesia induced at the affected portion of bursa, careful palpation of the whole accessible area of bursa follows. If the tender spot is found, it is infiltrated with 5 c c. of procaine solution, for diagnostic no less than therapeutic reasons. If no tenderness is detectable, and further consideration does not suggest that the lesion in fact lies at the inferior aspect of the acromio-clavicular joint, local anæsthesia has to be induced at the subacromial part of the bursa. Here the injection is of necessity given blindly ; hence two or three attempts may be required. These are well worth making ; for in my experience no other means of treatment exists.

3. INFRASPINATUS TENDINITIS

There is often a painful arc, sometimes even a double arc. In the latter instance the patient states that pain comes on at 80° and at 100°, but at the exact horizontal the pain is absent. I have not been able to fathom the mechanics of this phenomenon. In either case these painful arcs are associated with pain felt only on a resisted lateral rotation movement; they show the lesion to lie at the uppermost part of the tendinous insertion at the humeral tuberosity.

4. SUBSCAPULAR TENDINITIS

In this case, the painful arc is associated with pain on a resisted medial rotation movement. The presence of the painful arc singles out the upper extremity of the tendinous insertion at the lesser tuberosity.

5. TENDINITIS OF THE LONG HEAD OF THE BICEPS MUSCLE

This is an uncommon site ; the tendon is usually affected where it lies in the bicipital groove. The painful arc is associated with pain elicited by resisted supination of the forearm and resisted flexion at the elbow. The passive and resisted movements of the shoulder are all found painless.

6 SPRAIN OF THE INFERIOR ASPECT OF THE ACROMIO-CLAVICULAR JOINT

This is also rare. The painful arc is associated with the pattern suggesting that the acromio-clavicular joint is at fault (see p 212) Since the superficial fibres of the capsule are often strained at the same time, the superior aspect of the joint is found unilaterally tender However, if these fibres have escaped damage, differentiation of a lesion confined to the deep aspect of the joint from chronic subdeltoid bursitis may prove difficult. The fact that the scapular movements all cause slight aching and that the extremes of passive movement (especially adduction) at the shoulder joint hurt a little is indicative that the deep surface of the acromio-clavicular joint is at fault

7 METASTASES IN THE ACROMION

Secondary neoplasm of the acromion alone is rare It causes tenderness of the bone itself, demonstrated indirectly by the existence of a painful arc and detectable superficially by palpation. Localized warmth is found when erosion of bone is proceeding rapidly

The action of the supraspinatus muscle is grossly impeded. Hence the discovery of pain and marked weakness on testing abduction, associated with bony tenderness, leads to immediate radiography

8 CAPSULAR LAXITY AT THE SHOULDER

After a dislocation or sprain, residual capsular laxity at the gleno-humeral joint may give rise to momentary subluxation of the head of the humerus as the arm moves upwards towards the horizontal position At about 80°, it clicks back into place, perhaps with some discomfort. The examiner can see the momentary arrest of the movement and feel the click This is not a true painful arc, but the resemblance may be close, and its spurious nature must be realized

anterior and spinatus muscles, except in thin subjects, is difficult even at the deltoid muscle a minor degree of wasting is surprisingly difficult to see. Naturally, the examination for weakness must continue from scapula to hand for if the lowest cervical or first thoracic root or nerve-trunk is involved, it is only examination of the hand that affords the clue. The test for winging of the scapula must not be forgotten (see p 288)

Eleven possible findings are

1 *Painless Weakness of the Deltoid Muscle*

This may result from traumatic compression of the axillary nerve, usually by the head of the humerus when it dislocates The bony displacement may have been momentary only, spontaneous reduction occurring at once, hence there may not be clear history of dislocation A patient with a powerless deltoid but with a strong supraspinatus muscle possesses a full range of active elevation, but weakness of the resisted abduction movement is at once apparent when the two sides are compared Gross wasting of the deltoid is usually obvious and cutaneous analgesia is found at the mid deltoid area.

Treatment consists of maintenance of a full range movement at the shoulder joint, persisted in until the nerve recovers In my experience, rest in abduction is cumbersome and useless galvanism is also unnecessary

2 *Painless Weakness of Deltoid, Biceps and Both Spinatus Muscles*

This combination characterizes a lesion of the fifth cervical nerve-root. It may result from a *fourth cervical disc-lesion* If so, some of the cervical movements give rise to scapular pain If the cause is a *traction palsy*, a history of an accident depressing the shoulder girdle is obtained and the cervical movements are of full range and painless. *Infectious neuritis* seldom affects all the muscles derived from the fifth cervical myotome simultaneously on the rare occasions when it does, diagnosis may be difficult the most striking sign then is a far greater degree of weakness and wasting than characterizes the partial lesions caused by traction or disc-pressure.

patients, secondary limitation of movement may have occurred at the shoulders as a result of capsular contracture from disuse. The wasting, if perceived at all, is then ascribed to arthritis. The great wasting contrasts strangely with the small limitation of movement, and the fact that the passive range is greater than the active range of movement affords the clue. The serratus anterior muscles are often affected as well.

6. *Bilateral Weakness of the Muscles of the Shoulder and Arm*

The patient, who is often elderly, begins to ache all over and retires to bed with a disorder thought to be influenza or "generalized rheumatism." The aching eases after a week or two; he then finds himself too weak to get about and may spend a month or two in bed The cause is toxic peripheral neuritis. Examination shows bilateral weakness of all the muscles controlling the shoulder- and elbow-joints but not of the forearms and hands Further examination reveals equal weakness of the muscles of the buttocks and thighs. Spontaneous recovery takes at least six months, and may never become complete, some muscle weakness remaining permanently.

If the patient, during the month when he cannot move his limbs properly, has not had the range of movement at his shoulder-joints passively maintained, he reaches the practitioner of orthopædic medicine as a case of stiffness of the shoulder-joints. In fact, the capsular contracture is caused solely by disuse. Such cases must not be regarded as bilateral osteo-arthritis complicated by psychogenic muscle weakness. This history gives the clue; testing the muscles at the proximal extent of all four limbs is confirmative.

Prophylactic movement at the shoulder-joints obviates the need of any treatment after the patient is strong enough to get about. In neglected cases, gradual forcing of movement at the shoulders must be undertaken at once.

7. *Painless Weakness of the Serratus Anterior Muscle*

This weakness is detected when the patient is asked to elevate his arm actively. He is then found to have 15°

limitation of this movement, but elevation passively is found to be full and painless This means that there is a full range of voluntary movement at the shoulder joint but that active rotation of the scapula is defective. When the patient is asked to lean forward with his arms stretched out in front of him and to push against a wall, winging of one scapula at once becomes apparent The cause is a long thoracic nerve palsy—another manifestation of infectious neuritis Most patients suffer two or three weeks' constant aching in the scapular region and arm but the neuritis some times comes on painlessly Spontaneous recovery is the rule, and takes four to twelve months No treatment necessary

Partial weakness of the serratus anterior muscle is occasion ally detectable (with some difficulty) in a cervical disc lesion resulting in a fifth or sixth cervical root palsy A suggestion of winging is perceptible voluntary elevation of the arm is lacking in only the final 5°

Bilateral painless disappearance of the serratus anterior muscles characterizes myopathy

8 *Painless Weakness of the Infraspinatus Muscle Alone*

The cause is a rupture of the infraspinatus tendon it is rare. The patient is always elderly and has suffered some accident or overstrain involving the shoulder Examina tion reveals a painful arc accompanied by great weakness of lateral rotation of the arm since the teres minor muscle escapes, the movement can just be performed actively The weakness is permanent, and leads to painless capsular contracture anteriorly After a year 30 to 45° of lateral rotation range has been lost, abduction and medial rotation remaining full

He should be shown an exercise for the teres minor muscle and taught how to maintain the full range of movement, especially lateral rotation, at the shoulder joint. If the arc persists after a month, massage or hydrocortisone to the point of rupture should be instituted.

9 *Painless Weakness of the Subscapular Muscle Alone*

This too is rare and results from rupture of the subscapular tendon The history is of trauma followed by weakness at

to put right afterwards. For example, when a patient's upper limb is kept in a sling for some time for any reason, and no instructions about moving unaffected joints are given, the immobilization imposed upon the shoulder-joint is purely wanton.

Post-traumatic adhesions are very apt to form at the inferior aspect of the joint (see Fig. 29) where damaged folds of lax capsule lie in contact so long as the patient keeps his arm to his side. Since this is what he naturally does in order to avoid pain, treatment by early movement is essential after any sprain of the capsule of the shoulder-joint. The joint movement is maintained passively; active repetition follows.

Examination of the shoulder in cases of united fracture of the surgical neck of the humerus shows that, when treatment by movement is not instituted at once, stiffness supervenes rapidly from traumatic adhesive capsulitis. Hence in this type of fracture it is not the broken bone that governs treatment, but the damage done to the joint by a force sufficient to break bone. Any bruised shoulder, whether associated with a simple fracture or not, should be taken seriously and treated by immediate movement. In the case of fracture of the surgical neck, movement must of necessity be given passively for the first week. Since it is movement at a joint, no matter how effected, that prevents stiffness at a joint, passive movements are strongly indicated. During the first few days after an injury, anyone who tries will soon discover that the passive movement may be possible over quite an ample range at a time when no amount of encouragement can induce much active movement For the first fortnight after fracture of the surgical neck of the humerus, abduction is the principal movement to maintain. Rotation is more likely to occur at the site of the fracture than at the shoulder-joint and should therefore be avoided. When the abduction movement is carried out, the physiotherapist must place one hand on the shoulder and the other under the elbow (see Fig. 41) and press the fractured ends together. In this way the humerus is made to move in one piece as the physiotherapist abducts it; there is very little pain, and movement at the joint, not at the fracture line, is secured.

If the capsule has escaped damage and instead a tendin-

itis has resulted, treatment by early movement is ineffective massage to the affected part of the tendon is required When both capsule and tendon are damaged, active exercises

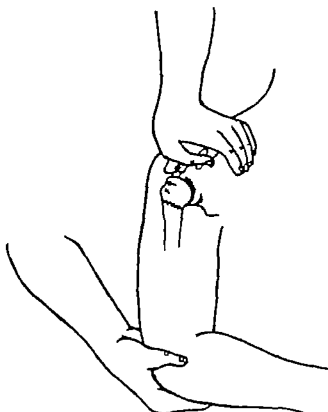


Fig 41 —Passive movement at the shoulder in recent fracture of surgical neck of humerus. The bone-ends are kept opposed by pressure exerted upwards from the elbow while the shoulder is held down. In this way a good range of movement can be maintained at the shoulder joint pending the return of active movement.

should be avoided at first for they naturally strain the tendon further Passive movements predominate until the tendinous lesion has responded to the massage.

ARTHRITIS AT THE SHOULDER

Treatment depends on the type of arthritis present (see p 205) and on its stage (see p 214)

When two disorders co-exist at the shoulder, the capsular lesion always takes precedence. Until full movement has been restored little advantage follows in treating *e.g.*, a tendinous lesion.

First Stage

In recent cases, whether due to traumatic capsulitis, osteo-arthritis or the very beginning of a freezing arthritis, the treatment consists in the gradual forcing of movement by the physiotherapist until it is full in every direction. This is rendered more bearable if the patient is given twenty minutes' short-wave diathermy, preferably every day during the first few weeks.

The physiotherapist gradually and firmly stretches the shoulder out as far as is possible without giving any jerk (see Vol. II). She may well spend five to fifteen minutes intermittently forcing elevation and, if necessary, adduction. In an early case the capsule stretches out gradually and silently; there are as yet no discrete adhesions requiring rupture. Finally, the patient repeats the movements actively.

In long-standing cases also in the first stage, the same treatment may suffice. Unlike the knee-joint, at which many small adhesions form, discrete bands limit movement at the shoulder-joint. After many days of short-wave diathermy followed by vigorous forcing of movement by the physiotherapist without apparent effect, a loud crack may be heard on one occasion. Thereupon the range of movement increases and the pain gets less After an interval the same happens again. Thus, the shoulder recovers by a series of sudden improvements punctuating stationary periods. Contrary to expectation, when large osteophytes engage and limit movement painfully, it is quite possible, by gentle manipulation of the joint, to render painless such movement as is obtainable.

Manipulation under Anæsthesia. This should be undertaken with caution, forethought and unwillingness. Occasionally in traumatic capsulitis or osteo-arthritis *in the first stage*, it is clear that fractional mobilization under general anæsthesia is required. In others the physiotherapist reports at the end of two or three weeks that her treatment is without effect upon the range of movement or the pain. If so, forcing under anæsthesia should be carried out at once. Just before the manipulation 25 mgr of hydrocortisone are injected into the joint, to diminish the inevitable reaction.

A small amount of pentothal given quickly suffices, since only half a minute's relaxation is necessary The patient lies supine on the couch The operator brings the patient's arm up as far as it will go without forcing allowing it to rotate so that his hand is pressing on the medial aspect of the elbow (see Vol II) This position enables elevation to be forced in the position of medial rotation this amounts to some degree of forced medial rotation Since the range of medial rotation is the movement most difficult to render full, and since this movement is best not directly forced for fear of fracturing the humerus, this position is important. Quite gentle forcing suffices, the operator continuing his pressure until one large band of adhesions is heard to part, *no more should be attempted*

The after treatment is vigorous and usually lasts several weeks. The physiotherapist, who should be present at the manipulation so as to see for herself how great a range of movement was obtained, repeats the same movement as soon as is convenient after the patient has come round from the anæsthetic and before he leaves the couch She asks him to keep repeating the movement and sees him again next morning at the latest. After heating the joint by short-wave diathermy, she then repeats the movement passively and induces the patient to perform it actively In not too-advanced traumatic capsulitis the joint should get perfectly well in the course of a month in osteo-arthritis a little symptomless limitation of elevation may remain (when advanced osteophyte formation limits movement, manipulation under anæsthesia is contra indicated) In due course, cases of considerable limitation of movement may again have to be forced under anæsthesia. So long as some of the added range of movement is retained, repetition may be considered but if none of the increase remains by a few weeks later, and the after treatment has been adequate, forced movement under anæsthesia is no more likely to be effective on the second occasion than the first.

Manipulation has no effect in acute or chronic subdeltoid bursitis a full range is found to exist under anæsthesia but the symptoms and limitation of movement remain unaltered when the patient regains consciousness. Massage, whether superficial or deep has no place in the treatment of

capsular lesions at the shoulder-joint, for the capsule lies out of effective reach of the physiotherapist's finger.

Freezing Arthritis. If the onset is very recent, this occasionally responds well to gentle stretching out of the joint after it has been heated by short-wave diathermy. More often, however, the condition proves intractable by this means and increasing pain and limitation of movement set in despite adequate treatment. At this point, a common error is to manipulate under anæsthesia. Here lies the reason for manipulation at the shoulder having achieved such a bad name that many surgeons have given it up altogether. The result of an ill-timed manipulation is a markedly diminished range of movement at the shoulder, obvious by the next morning, and an extra one or two months' severe pain. The proper treatment during the later part of the first stage is the induction of a stellate block; this should be performed at once (see p. 646) since it is the only measure known to me that can abort the full cycle of the freezing. In most cases, unhappily not in all, two, three or four stellate blocks carried out at fortnightly intervals reverse the otherwise inevitable aggravation and, in the course of a month or two, bring the shoulder into the state that it should have reached some six to eight months later, *i.e.* into the stage of spontaneous improvement After the first stellate block, the pain at night that has been interrupting the patient's sleep usually ceases for a fortnight. Its return is the indication for the next infiltration

Freezing arthritis of eight or more months' duration re-enters the first stage and responds very well to short-wave diathermy followed by stretching out of the joint. This hastens cure; a full range of movement may be regained in, say, six weeks when spontaneous recovery would have taken four months Manipulation under anæsthesia is also successful at this stage, but several weeks' after-treatment is required. Hence little time is saved and there is little advantage in this more forcible treatment.

Through the kindness of Dr. Prunty, cortisone therapy was tried on two cases of freezing arthritis in the early stage. Two hundred milligrams a day were given for two days and a hundred a day for a further ten days. The arthritis was uninfluenced by this treatment and continued getting worse

at its previous rate. In nine cases, hydrocortisone was injected intra-articularly—in all without effect. This intractability by cortisone confirms the distinction between freezing and infective arthritis

Infective Arthritis Even when fully within the first stage, this condition provides a permanent contra-indication to forcing movement at the joint whether by the physiotherapist after heat or, even worse, under anæsthesia This fact provides the practitioner of orthopædic medicine with one of his knottiest problems. When more than one joint is involved a clear pointer to the diagnosis exists. But in early monarticular infective arthritis of the shoulder joint, with little muscular wasting minimal or absent radiological changes and no rise in the sedimentation rate, the diagnosis between early freezing arthritis, or even (should injury figure misleadingly in the history) traumatic capsulitis, may be wellnigh impossible. The fact that the patient is quite young and the onset unprovoked weighs the scales in favour of a rheumatoid origin.

The treatment of choice is hydrocortisone injected into the shoulder joint. By the same evening pain has eased and within a week the range of movement has begun to increase Two to four more injections at fortnightly intervals afford ample relief In the shoulder-hand syndrome oral cortisone appears more effective than intra-articular hydrocortisone supplemented by repeated stellate blocks.

It should be clear from the above remarks that *nothing is easier than to force movement at the shoulder-joint under anæsthesia, whereas to know when to carry this out and in particular when to abstain requires a great deal of judgment and careful thought.*

Second Stage

Apart from intra-articular hydrocortisone, the only treatment required consists of short wave diathermy administered daily followed by passive maintenance of range

It is in these difficult cases that a really experienced physiotherapist who is afforded plenty of time in which to exercise her skill proves so valuable. Capsular shoulder lesions just entering or on the edge of getting beyond, the

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It is in these difficult cases that a really experienced physiotherapist who is afforded plenty of time in which to exercise her skill proves so valuable. Capsular shoulder lesions just entering, or on the edge of getting beyond the

treatable stage can be coaxed towards improvement by careful treatment If she pushes the joint too hard she gives the patient added pain and less movement; if she is too gentle she accomplishes nothing. A good rule is to give just such a treatment as makes the patient complain of one to two hours' slightly increased ache at the shoulder after each session. She may even find that slight forcing of one movement makes the patient worse; yet forcing another movement does good. At each visit, she asks carefully about the reaction to her treatment and estimates the range of movement; she bases the technique of each treatment on the response to the previous one.

Third Stage

If, in spite of painstaking treatment, the range of movement diminishes, immobilization in a sling should be instituted at once. There is nothing for it but to allow the shoulder to stiffen further. Rest lets the activity of the lesion abate, thus hastening eventual arrival at the stage when active treatment becomes once more possible. Local anæsthesia induced at the stellate ganglion provides the only hope of aborting the progressive increase in pain and limitation of movement and should be induced at once. It is often just a question of time. The administration of analgesics, especially at night, diathermy and wearing a sling by day make the period of waiting more bearable in those cases intractable by stellate anæsthesia.

The above remarks apply to freezing arthritis but not to traumatic or infective arthritis, in which hydrocortisone is the treatment of choice. In the case of traumatic arthritis, as soon as the third stage has been aborted by the action of this hormone, gentle forcing after deep heat is begun.

THE SUBDELTOID BURSA

LOCALIZED BURSITIS

If there is no thickening of the bursal wall, local anæsthesia is induced as often as is necessary for cure; seldom more

than two or three times After careful palpation to outline the exact spot, local anæsthesia (5 c c. of 0 5 per cent procaine solution) is induced at the affected part of the bursa. For the duration of anæsthesia, the painful arc disappears Marked improvement may be expected to follow each correct induction. When the subacromial part of the bursa is affected, palpation reveals nothing, and the injection has to be given blindly The anterior the middle and the posterior part of the subacromial extent of the bursa are one by one infiltrated with 10 c.c. of 0 5 per cent. procaine solution The area yielding abolition of the painful arc is noted so that the physician knows where to inject next time, if more than one treatment is required.

When the bursitis is secondary to advanced rheumatoid arthritis, the wall is thickened, but is not the cause of symptoms and requires no treatment. If aspirated, the bursa soon fills up again

TRAUMATIC BURSITIS

This occurs as the result of direct injury, *e.g* a plank falling on the outer aspect of a man s shoulder and is usually accompanied by an effusion into the bursa.

In recent cases massage is extraordinarily effective and may restore, say, 80° limitation of elevation to full range after twenty minutes This is the best that can be hoped for from local anæsthesia of the affected part of the bursa and carries the double advantage of not being followed by after pain and of having a more lasting therapeutic value. The aim of massage is merely to get rid of local bruising and swelling Since the bursal wall is not a striated structure, the direction in which the physiotherapist's thumb moves is immaterial. The friction is always given gently and for a long time (see Vol II)

In long standing cases local anæsthesia or hydrocortisone provides the treatment of choice

Mobilization under general anæsthesia has no place in the treatment of subdeltoid bursitis at any stage.

ACUTE BURSITIS

The treatment is short-wave diathermy and rest in a sling. Short-wave diathermy should be given for a full half-hour daily.

The patient is continually woken at night by severe pain when he moves in bed. The absence of involuntary muscle spasm allows this to happen. A figure-of-eight bandage applied about the thorax and the affected arm gives the patient a good night's rest.

As soon as the symptoms indicating subsidence of the bursitis are reported, the sling may be gradually abandoned, and the diathermy continued while passive movements are cautiously begun.

BURSITIS WITH CALCIFICATION

Acute Episodes

Although remaining symptomless for years at a time, calcification renders a patient liable to attacks of acute bursitis; if so, severe pain accompanied by little or no movement at the shoulder-joint results from a subdeltoid bursitis of sudden onset which within a few days has already reached the third stage. The treatment consists of a sling and a full half-hour's short-wave diathermy daily.

Persistent Pain

If calcification gives rise to lasting symptoms—and it must be remembered that the presence of a small shadow on the radiograph provides no guarantee that it is the cause of whatever symptoms attributable to the shoulder the patient may have—local anæsthesia is the treatment of choice. Whether the acid solution dissolves the deposit or acupuncture liberates it—indeed, the two actions may be combined—is uncertain, but the results are usually good. Radiotherapy is said to abolish pain and to lead to disappearance of the deposit, but did so in only one out of ten cases thus treated at my request. Spontaneous disappearance of the deposit and of the symptoms may take place in the course of two or three years. Even this is not invariable; for I have seen

deposits persist for up to seven years Removal of the deposit at open operation is not often required, but is very successful.

HÆMORRHAGIC BURSITIS

Aspiration is all that is required It may have to be performed more than once.

TENDONS AND MUSCLES

In muscular and tendinous lesions the essential treatment is deep friction, in the former case exercises follow, in the latter case the patient should be warned to avoid any movement that hurts.

At the shoulder, the properly trained physiotherapist figures very prominently Tendinitis is common and usually incurable except by deep accurate massage, which (provided that it is adequately given) very seldom fails The fact that orthopædic surgeons still carry out an operation—removal of the acromion—for the relief of supraspinatus tendinitis shows how few physiotherapists are able to give precise massage. This operation abolishes the painful arc but leaves the tendinitis, it thus helps a little. It also has the unintentional merit of making for better access for the physiotherapist's finger and has thus enabled us to cure cases both of infraspinatus and of supraspinatus tendinitis with greater ease than in unoperated cases

Hydrocortisone also cures tendinitis at the shoulder, but great accuracy in the siting of the injection is essential.

THE SUPRASPINATUS TENDON

Tendinitis

This common lesion often fails to get well of itself hence cases lasting say, twenty years are often encountered. Once a bowler gets it, he may never be able to play cricket again Yet, deep massage and hydrocortisone are curative, even years later In cases of less than a year's standing there should be no failure The tendon may be affected at

1. The superficial aspect of the teno-periosteal junction.
2. The deep aspect of the teno-periosteal junction.
3. The musculo-tendinous junction.

All get well with proper friction, but the physiotherapist's technique naturally varies with the position of the lesion. Only the first two lesions respond to hydrocortisone.

Calcification in the Tendon

A large deposit of calcified material sets up the symptoms and signs of tendinitis (see Plate 10), tiny nodes have no significance.

Local anæsthesia should be induced at the deposit once every week or two until the symptoms cease; six to twelve injections of 10 c.c. are usually required. Once more, whether the acid solution of procaine hydrochloride dissolves the deposit, or the acupuncture releases it—or both—is uncertain.

In the event of the injections failing, removal of the deposit at open operation is curative within a few weeks.

Complete Rupture

Treatment in the first few weeks consists of friction to the medial aspect of the greater tuberosity, so as to smooth off the strands of tendon adherent to the bone there. The full passive range of movement is maintained by the physiotherapist, who also shows the patient how to achieve it daily. Secondary capsulitis from disuse may have supervened by the time the patient is first seen and cause slight limitation of movement; this is treated by passive forcing until a full range of movement is restored. Exercises (and perhaps faradism) to the deltoid muscle are called for. Lastly, the patient should be shown how to initiate an abduction movement of the arm by placing his hand against the outer side of his thigh and then giving a twitch to his hip and simultaneously bending his trunk over to the opposite side. The supraspinatus muscle alone begins an abduction movement; this manœuvre swings the arm outwards to the point where the action of the deltoid muscle becomes effective. The painful arc seldom persists; if it does the massage,

occasionally supplemented by local anæsthesia or hydrocortisone, hastens its disappearance

With this treatment, patients lose their painful arc in four to eight weeks, and go back to all but the heaviest work in three to four months. Some permanent loss of power of abduction is inevitable, but a full painless range is present on voluntary movement. It is doubtful if operative suture of the ruptured tendon is ever worth while.

Incomplete Rupture

The lesion may be regarded as a very severe tendinitis If the pain warrants, the arm may be kept in a sling for the first few weeks, while the tendon is receiving massage However a full range of movement at the shoulder must be maintained passively for pain and weakness combine to prevent the patient himself maintaining adequate movement. Deep massage is given to the affected part of the tendon (see Vol. II) This treatment usually brings about full recovery in two to three months without such treatment disablement is often permanent. Injection of hydrocortisone may be required

INFRASPINATUS, SUBSCAPULARIS AND LONG BICEPS TENDONS

Infraspinatus tendinitis gets well with adequate deep massage or injections of hydrocortisone Failing such treatment, it usually goes on indefinitely

Deep massage is far more painful and in general less successful in subscapular tendinitis than when either spinatus tendon is affected Injection of hydrocortisone is particularly easy, for the lesser tuberosity is readily felt lying medial to the bicipital groove. Since one or two infiltrations usually suffice the injection is preferable to massage.

Bicipital tendinitis responds to massage excellently Even cases of many years standing, which have proved resistant to every other treatment, are uniformly relieved by four to six sessions of proper massage given twice a week.

PECTORALIS MAJOR AND LATISSIMUS DORSI MUSCLES

Local anæsthesia usually has a good lasting therapeutic effect on lesions of the belly of these two muscles; should it fail, deep massage is quickly effective. When the tendinous insertion of the pectoral muscle at the bicipital groove has been strained, massage is the only effective treatment.

RECURRENT DISLOCATION OF THE SHOULDER

When this occurs in young men, as it usually does, the treatment should be surgical, but in fact none of the many operations now in vogue is free from some liability to recurrence. It is, therefore, worth while giving conservative treatment a trial first.

Since the muscle responsible for pulling the head of the humerus out of its socket is the subscapularis, this must be weakened as much as possible in relation to its antagonist. Hence, general exercises to the shoulder are useless. The subscapularis muscle must be stretched out by prolonged passive forcing of lateral rotation while the arm is held as far back as possible and horizontal. Its antagonist, the infraspinatus muscle, must then be strengthened by strong repeated resisted lateral rotation exercises.

SUBLUXATION OF HUMERAL HEAD

When a false painful arc occurs at the shoulder as the result of subluxation upwards of the head of the humerus during abduction, the patient must be taught how to depress the humerus. He can avoid the upward movement by using his pectoralis major and latissimus dorsi muscles; the physiotherapist teaches him how to do this.

ACROMIO-CLAVICULAR JOINT

When this joint is affected, usually after a fall on the shoulder, the patient complains of pain exactly at the site of the joint. There may be a slight aching in the upper deltoid area as well, but such reference is uncommon and

does not deceive, for when asked to indicate whence the pain springs, the patient places one finger on, or very close to, the joint. Rarely the inferior aspect of the capsule bears the brunt of an injury In such cases, the pain at the joint is sometimes felt to travel as far as the mid-arm and a painful arc may then occur on abduction at the shoulder Hence a puzzling picture emerges, very similar to that of supra spinatus tendinitis or subdeltoid bursitis In such cases, local anæsthesia may have to be employed to clarify the diagnosis

The extremes of all passive and active movements at the shoulder impose a strain on the joint and may thus cause pain Even full adduction of the arm hurts by pressing the joint surfaces together Downward traction and backward movement from the horizontal position are often the movements that hurt most. The weight of the arm dragging on the joint-capsule sets up tension and causes pain. If this can be eased by pressing the arm upwards into its socket, the diagnosis is assured No other condition about the shoulder can be alleviated in this manner, except a recently reduced dislocation of the humerus, in which the history is, of course, characteristic. The site of pain and the presence of localized tenderness over the joint thus provide the main features distinguishing between an acromio-clavicular joint lesion and the earliest signs of a capsular lesion at the shoulder joint.

Severe stretching of the joint leads to laxity and a tendency to subluxation, which may be visible and is usually easily palpable Recurrent subluxation soon becomes painless and is limited by the length of the conoid and trapezoid ligaments It does not constitute any disability in itself and in any case the capsular laxity is permanent. Osteophyte formation of the acromio-clavicular joint leads to prominence of the ends of the bones, these may be slightly tender Such osteo-arthritis seldom causes any symptoms, but is a common radiographic finding in elderly patients. It is thus usual to find patients credited with a lesion of the acromio-clavicular joint on the strength of misapplied x ray findings, though the most cursory examination would have revealed, for example, limitation of movement at the shoulder joint. It is obvious, I hope, that no degree of arthritis at the

CHAPTER XII

THE ELBOW

THERE is no line of demarcation between the shoulder and elbow regions. The source of a pain felt in any part of the arm lies most often at or near the shoulder-joint. When the muscles of the arm are affected, the patient can often point to a small area as the site of his pain. But he may have a precise idea of whence his pain springs and yet be quite wrong; hence his indication need be given weight only if it lies within the structure shown by examination to contain the lesion. A very common false localization is at the insertion of the deltoid, a site at which most persons are tender. Thus, a most misleading picture emerges unless the diagnostic movements are studied.

If the instructions at the beginning of Chapter IX are followed, obscure pains felt near the shoulder and in fact originating from the muscles of the arm will be distinguished at once.

EXAMINATION

Pain arising in the cervical, thoracic outlet, scapular or shoulder areas may be felt most intensely in the arm, sometimes in the forearm. Equally, pain arising in the arm may be felt in the elbow or forearm. Again, pain in the forearm may be referred up into the arm or down into the hand. Since, then, the pain may be in much the same place wherever its origin may lie, the movements of the neck, the scapula, the shoulder, the elbow, the wrist and the fingers must all be examined. In the more distal part of the upper limb the patient's capacity for localization is good; hence, if he indicates a definite spot in his forearm, wrist or hand he may be correct. If, on the contrary, he describes the pain as occupying an ill-defined area, it is almost certain that a pain referred from above is present.

During the examination of the elbow, the same four move-

ments are tested, first passively, then against resistance Flexion, extension, pronation and supination are examined, the range is noted and whether pain is set up or not If the range is limited, the proportions indicating a capsular or a non-capsular pattern are noted The resisted movements at the wrist must be included, since the muscles controlling the wrist take origin from the elbow and painful lesions in them may set up symptoms felt entirely at the elbow (see Tennis Elbow, p 272, and Golfer's Elbow, p 288)

PASSIVE MOVEMENTS

The passive range of flexion, extension and rotation is ascertained Limitation of flexion and extension indicates arthritis only in advanced cases is rotation found limited as well Palpation of the joint may reveal warmth, an effusion, synovial thickening a bursa, crepitus, or clicking

The capsular pattern for the joint is an approximately equal degree of limitation of flexion as of extension Sometimes flexion is a little more restricted than extension, *e.g* 45° limitation of flexion and 30° limitation of extension Rotation is of full range in all but severe degrees of arthritis, it begins only when some 45° of limitation of flexion and of extension is present.

Pain felt at the wrist on the extremes of passive rotation of the forearm incriminates the lower radio-ulnar joint.

The following types of articular disorder occur

1 *Traumatic Arthritis*

Curiously enough, this shows itself as an affection confined to the humero-ulnar joint. After an injury to the elbow of any severity, flexion and extension are found markedly limited and painful, but rotation of full range and painless In other words an arthritis exists at the humero-ulnar joint but not at the radio-humeral and radio-ulnar joints. Should rotation be found painful in a patient with an acute traumatic arthritis at the elbow the head of the radius is almost certainly chipped or cracked The radiograph is then diagnostic.

The interesting question arises of the relationship of traumatic arthritis of the elbow joint to traumatic *myositis of*

the brachialis muscle. On the one hand, resisted flexion of the forearm does not hurt in traumatic arthritis; hence there is nothing on immediate clinical examination to suggest a lesion of the brachialis muscle. Moreover, flexion is greatly limited, not merely painful at its extreme—a point at which a tender part of the muscle might lie squeezed between humerus and ulna. I have had the good fortune once to see a case of traumatic arthritis of the elbow in a patient with already gross weakness of the flexor muscles of the elbow as the result of a traction palsy occurring after an operation on the neck. In spite of the weakness, flexion and extension at the joint were limited as in a patient with normal muscles. These three findings suggest that the brachialis muscle is not involved in traumatic arthritis. On the other hand, three conflicting facts emerge, all of which suggest that there is some connexion. These are: (1) Untreated cases of traumatic arthritis (or those treated actively) may later develop myositis ossificans. If the late stage is an obvious affection of the brachialis muscle, what was the early stage? (2) Resting the elbow in flexion in due course restores the range of extension to the joint. This position rests the brachialis muscle and, were an irritative lesion present, should let this subside. Analogy with other join ... ts that in a purely articular disorder fixation in fle ... likely to lead to an increase in the rang ... isted extension tested at mid-range ... thritis at the elbow. In a pure ar ... movements should hurt, but resi ... duce reflex relaxation of the brac ... change in muscular to ... ar from the ... mechanism ... elbow—in ... ositis of t ...

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elbow is held as flexed as possible, and flexed more day by day until full flexion is achieved This position is held for, say, a fortnight, then the elbow is rested in slightly less flexion. If, three days later, examination shows the range of flexion to remain full, the forearm is let drop a little further If, by contrast, relinquishing full flexion leads to loss of the flexion range, rest in full flexion is instituted again for say, a week. Immobilization in less flexion is then tried again.

If this regimen is followed, enough range at the elbow is usually regained after six weeks to enable the patient to wear a sling instead of collar and-cuff bandage At the end of two or three months a full range of painless movement has returned to the joint.

All efforts to speed recovery by massage, exercises or, worse, passive stretching of the joint defeat their own ends They lead to irritation of the joint (or brachialis muscle) and increased limitation of movement. They may also lead to the development of myositis ossificans, and it would be scarcely possible to defend a medico-legal action were this 'treatment" given with such a result.

2 *Myositis Ossificans*

In established myositis ossificans of the brachialis muscle only a little movement to either side of the right angle is possible Rotation is also markedly limited The bony tumour is sometimes easily palpable and it shows clearly on the radiograph I have met with one case of recurrent osteomyelitis of the new bone laid down within the muscle No treatment avails. Excision of the bony mass seldom helps.

3 *Loose Body in the Joint*

In adolescence, a loose body (sometimes two or three) results from osteochondritis dessicans or a chip fracture. The loose fragment thus has an osseous nucleus which shows on the radiograph Between the ages of thirty and fifty, loose fragments, sometimes wholly cartilaginous and thus casting no shadow on radiological examination, may set up chronic internal derangement. They appear to result from

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It is clear from the above conflict of evidence that the nature and mechanism of post-traumatic limitation of movement at the elbow—in particular its connexion or not with an acute myositis of the brachialis muscle—is not yet fathomed.

Treatment. Whether the lesion is of the joint or of the brachialis muscle may not be clear, but there is no difference of opinion on the nature of the treatment, which is *rest in flexion.* As soon as the patient is seen his elbow is immobilized in flexion by a collar-and-cuff bandage If full flexion is no longer attainable at the patient's first attendance, the

elbow is held as flexed as possible, and flexed more day by day until full flexion is achieved This position is held for say, a fortnight, then the elbow is rested in slightly less flexion. If, three days later examination shows the range of flexion to remain full, the forearm is let drop a little further If, by contrast, relinquishing full flexion leads to loss of the flexion range, rest in full flexion is instituted again for, say, a week. Immobilization in less flexion is then tried again

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In adolescence, a loose body (sometimes two or three) results from osteochondritis dessicans or a chip fracture The loose fragment thus has an osseous nucleus which shows on the radiograph Between the ages of thirty and fifty, loose fragments, sometimes wholly cartilaginous and thus casting no shadow on radiological examination, may set up chronic internal derangement. They appear to result from

exfoliation of articular cartilage. In elderly patients, loose bodies, often multiple, form secondarily to osteo-arthritis These are once more osseous, and show clearly on x-ray examination. It is thus in the middle-aged group that diagnostic difficulty arises. The condition is usually mistaken for tennis-elbow, but employment of the methods of examination recommended in this book eliminates error, for passive movement at the elbow is found painful and resisted extension at the wrist not. Rarely, the two disorders appear simultaneously; this coincidence of two lesions has an important bearing on treatment and must be noted, since Mills's manipulation for a tennis-elbow is contra-indicated unless the joint possesses a full and painless range of extension.

The patient may state that the elbow has clicked in the past or that he has had previous transient painful attacks One day, during some exertion, the elbow begins to ache and stiffen. The onset has seldom the dramatic suddenness of internal derangement at other sites, and I have even known patients go to bed comfortable and wake up in pain Examination of the joint at once shows disproportionate limitation of movement There is perhaps 10° or 20° limitation of passive extension, with pain at the extreme; whereas flexion is full and painless. Rotation is of full range, but nearly always painful in one or other direction, more often supination, which may be accompanied by a click. When this non-capsular pattern is encountered, the loose fragment lies in the triangle formed by humerus, radial head and coronoid process. Rarely the loose fragment comes to lie between the humerus and the tip of the coronoid process of the ulna. Passive flexion of the elbow is then 45° to 60° limited, extension and rotation remaining of full range and painless In either case, the radiograph may or may not demonstrate the position of the loose body.

The real diagnostic difficulty in these cases lies between an impacted loose body and a minor degree of traumatic arthritis. The history of trauma and the absence of sudden onset do not deceive when the presence of a non-capsular pattern is revealed When a loose body has moved, but not in traumatic arthritis, not only is extension limited and painful, but rotation is found to be painful too

Treatment. Loose bodies limiting extension can often be

reduced (see Vol. II) In my experience, a loose body limiting flexion cannot be shifted the patient must either submit to operative removal or put up with the minor disability

4 *Osteo-arthritis*

This may come on for no apparent reason in late middle age and is often bilateral Alternatively it may follow fracture involving an articular surface Quite often the only symptoms are aching after considerable exertion and inability fully to extend the joint. Examination shows that 10° or 20° of limitation of flexion and of extension is present, the movement ending abruptly with the sensation of bone to-bone Coarse crepitus is often palpable. Forcing is uncomfortable rather than painful. This discomfort and the slight limitation of movement differentiate osteo-arthritis from the gross painless limitation of neuropathic arthropathy In the latter case the radiograph is diagnostic. By contrast, x ray evidence of osteo-arthritis at the elbow is compatible with a full range and painless function at the joint.

Treatment As a rule, none is required. Occasionally, stretching the joint out after it has been heated by short wave diathermy makes the extremes of movement painless but without increasing range.

5 *Osteo-arthritis with a Loose Body*

Osteo-arthritis is often complicated by the presence of one or more loose bodies, displacement of which gives rise to attacks of pain seldom lasting more than a week or so These attacks are not abrupt, they come on in the course of hours and subside equally gradually Impaction of the loose body is uncommon, but, should it occur disimpaction by manipulation is seldom difficult (see Vol II) The history is indicative for an elderly patient complains of slight long-standing aching in his elbow, punctuated by attacks during which the elbow loses most of its movement. Between attacks, examination reveals merely the osteo-arthritis (see above) During an attack, gross limitation of recent onset makes the diagnosis clear The radiograph is confirmative, but not all patients

with loose bodies in their elbow suffer attacks of internal derangement

Manipulative reduction should be carried out (see Vol. II).

6. *Infective Arthritis*

When other joints are affected as well, the rheumatoid origin is clear. In acute or subacute mon-articular infective arthritis, the joint is warm and the capsule thickened; this is best detected by palpation over the head of the radius laterally. Marked limitation of flexion, extension and rotation is associated with muscle wasting. Intra-articular hydrocortisone is the treatment of choice. In the chronic stage, movement remains limited and a characteristic silken crepitus is palpable on movement. Decalcification and, later, erosion of cartilage are visible on the radiograph. The distinction should be made between involvement of the joint in the course of rheumatoid arthritis, or as a complication of gonorrhoea, spondylitis deformans, or tertiary syphilis. If the symptoms warrant, immobilization in a sling or in plaster is called for.

7 *Bacterial Arthritis*

This may be septic, tuberculous or complicate an abscess in the bones at the elbow. Antibiotics and immobilization in plaster are indicated.

8. *Ligamentous Sprain*

Sprains of either collateral ligament are uncommon and recover quickly, provided the patient avoids straining his elbow for the time being. The author's method of treating a tennis-elbow involves repeatedly spraining the radial collateral ligament but no harm has ever come of this. Calcification in either collateral ligament giving rise to slight limitation of movement is a rare occurrence, not amenable to active treatment The radiographic appearances are diagnostic.

9 *Pulled Elbow*

I have never met with a case myself. It occurs when children are pulled along by the hand too forcibly The radius is displaced vertically downwards, this is demonstrated best on a radiograph not of the elbow but of the wrist (which has been shown to me) The resulting articular disturbances at the elbow and the lower radio-ulnar joints must give rise to limitation of movement. Magill and Aitken (1954) state that extension is 20° limited and that forcing is met by a rubbery resistance Reduction is immediately secured by rotating the forearm rapidly to and fro with the wrist held in radial deviation and at the same time pushing the radius upwards towards the humerus by pressing the elbow against a resistant surface.

RESISTED MOVEMENTS

The active movements of the elbow should now be examined against resistance. The examiner should apply the resistance with his hand on the patient's lower forearm for, should the movement be resisted by pressure against the hand pain will also be elicited from the muscles controlling the wrist joint.

Pain may be felt or weakness discovered on the following resisted movements, always associated, except in double lesions, with a full range of movement at the joint.

1 *Resisted Flexion*

This finding indicates a lesion of the biceps muscle since lesions of the brachialis muscle (if indeed they are lesions of this muscle see p 200) do not result in pain on resisted flexion. Confirmation is found when resisted supination is found also to hurt (see Fig 48) The lesion may lie at one of four sites

(*a*) *At the Long Head of Biceps* The tendon is nearly always affected at the upper part of its extent in the groove on the humerus, and the patient states that the pain is felt at the shoulder The only way to find out which part of the tendon is involved is by palpation for tenderness along its course Local anaesthesia affords no added precision Find

ing the right point is vital; for cases of even ten or ı years' standing, that have resisted every treatment, are manently cured after three to six sessions of proper mas: given to the exact spot (see Vol. II).

(*b*) *In the Belly of the Biceps.* A minor rupture at anterior aspect of the muscle causes no symptoms once immediate pain and bruising have cleared A symptor swelling is present at mid-arm, which contracts with rest of the muscle. When, however, a few muscle fibres at the posterior aspect of the belly, pain in the arm re: that may persist on certain movements for months or y Spontaneous cure usually takes two years in patients

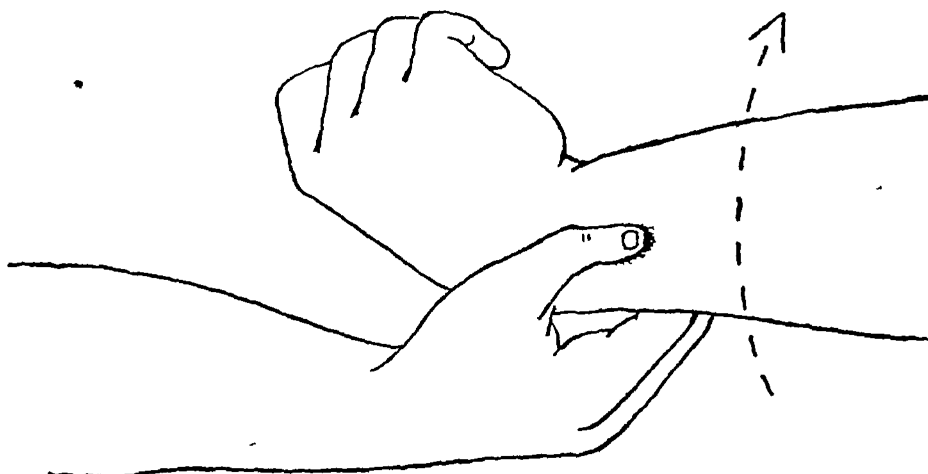


FIG 43 —Resisted supination at elbow-joint The examiner resists supination movement by pressure exerted at the lower forearm

avoid straining the muscle during this time; in those continue at heavy work the symptoms may go on indefinit

The area of tenderness at the back of the belly musl sought by pinching the deep aspect of the muscle betw finger and thumb; palpation from in front is no help. W the probable site of the lesion has been found, local anæsth should always be used as confirmation, for it is diffi otherwise to make an exact localization. The injection oi has a good therapeutic effect, especially in recent cases, in any case shows the physiotherapist exactly where to g the deep massage. This is quickly effective (see Vol. II

(*c*) *At the Lower Musculo-tendinous Junction.* The p is felt at the lower arm and palpation confirms its site. L

anæsthesia is usually required for confirming the diagnosis, but it has no therapeutic value Unless properly treated, a lesion at this point in the muscle is apt to go on hurting indefinitely for it has occurred at a point where the natural mobility of muscle is restricted by the presence of tendinous strands Hence the patient's active efforts have no effect, whereas deep massage is curative

(d) *At the Lower Teno-periosteal Junction* At this level the position of the pain is distinctive and a localizing sign exists. The patient complains of pain felt to start at the centre of the front of the elbow radiating down the front of the forearm as far as the wrist. Resisted flexion and supination elicit the pain, so does full passive pronation at the elbow joint. This indicates that the tenderness is evoked by pressing the tuberosity of the radius against the ulna in other words that the lesion lies at the tuberosity It is particularly fortunate that pain can be elicited in this way, for deep palpation in the area is very painful in normal individuals

Three months rest in a sling is curative, if the patient goes on using his arm he may never get well Deep massage given adequately brings about recovery in about three weeks (see Vol II)

Weakness of the Biceps Muscle This occurs in fifth and sixth cervical root palsies in the former case in conjunction with weakness of abduction and lateral rotation of the arm in the latter in conjunction with weakness of the extensors of the wrist.

2 *Resisted Extension*

This seldom sets up pain since lesions of the triceps are uncommon If this muscle is affected, the usual site for the lesion is the musculo-tendinous junction, deep massage is quickly curative If the olecranon is fractured, pain is accompanied by weakness and marked articular signs at the elbow joint. The examiner must be on his guard against mistaking for a tricipital lesion the pain felt in traumatic arthritis of the elbow joint (see p 259) when extension is resisted

Weakness of the triceps muscle occurs in two disorders

(a) *Radial Palsy* This is usually due to pressure from a

15 c.c. of fluid. In another, an area of calcification half an inch across was shown on the radiograph In none of the cases was an appreciable degree of pain mentioned. Radio-humeral bursitis can be detected only if calcification has made it visible on the radiograph and even then the distinction between this condition and calcification in the radial collateral ligament is by no means clear. Bursal affections have been mistaken for tennis-elbow, but as no pain is set up when the resisted movements at the wrist-joint are tried, examination on the lines laid down in this chapter distinguishes tennis-elbow immediately.

TREATMENT

Aspiration followed by protection is called for. When hæmorrhage into a bursa has taken place, aspiration alone is usually curative Often the patient is merely anxious to know what the swelling is due to; if so, reassurance as to its harmless nature suffices. Septic bursitis requires a wide incision and antibiotics.

When pain or swelling persists in spite of relief from the causative traumata, bursæ may be excised if the symptoms warrant. According to Carp (1932) the radio-humeral bursa can be burst by manual pressure against the head of the radius, but I have no personal experience of this treatment.

Large round bilateral swellings attached to the posterior aspect of the shaft of the ulna about $1\frac{1}{2}$ inches below the olecranon occur in (1) tophaceous gout, (2) rheumatoid arthritis, (3) xanthomatosis If they cause annoyance, surgical removal is indicated

NERVES AT THE ELBOW

THE ULNAR NERVE

Friction against the sheath of the ulnar nerve at the medial humeral condyle gives rise to little or no aching at the elbow, but to paræsthesiæ at the fourth and fifth fingers. In recurrent dislocation of the ulnar nerve, complaint that something goes out and in at the elbow is also made. Structural abnormalities at the elbow, such as the cubitus valgus that

may occur developmentally or as the result of a malunion of a condylar fracture, may cause friction here on account of the altered stresses on the nerve Some cases result from a fall on the elbow, and are post traumatic in the sense that a bruising of the nerve sheath sets up an irritability that elbow flexion habits may now maintain Many cases are postural, the patient sleeping with his elbow bent up under him, or he may hold a telephone receiver to his ear for hours on end, or enjoy lying supine, his hands at his occiput.

Examination in the first place reveals that the patient is not suffering from (a) a seventh cervical disc lesion (b) costal pressure on the lower trunk of the brachial plexus (c) a ganglion in connexion with the flexor carpi ulnaris tendon (d) occupational pressure on the ulnar nerve at the proximal part of the palm. The fact of an old injury to the elbow is soon apparent when the joint is examined Keeping the elbow bent for some time, if the joint itself is normal, may bring on the symptoms Unfortunately, no such test as stretching the nerve by a full radial deviation movement of the hand while the elbow is kept fully flexed has proved helpful in diagnosis. Friction on the nerve-trunk is suggested by finding tenderness of the nerve-sheath the two sides must always be compared Thickening, especially in cases of recurrent dislocation, may be great enough to produce a spindle-shaped swelling of the nerve at the back of the elbow Local anaesthesia provides the only satisfactory diagnostic criterion in early cases in late cases an ulnar palsy apparent on examining the hand makes the diagnosis obvious

Treatment

1 *The Avoidance of Postural Strains or Pressure* Keeping the elbow bent for any length of time, or resting the inner side of the flexed elbow on the arm of a chair or on a desk while writing must be avoided A cushion under the forearm to raise the elbow off the desk may suffice The substitution of a hard for a soft arm to the chair enables the olecranon to bear all the weight of the arm Those who wake in pain may have to wear a light splint to prevent postural strains while asleep It is important to study the patient's daily

(1921) on the other hand believed the fault to lie in the superficial epicondylar bursa, first described by Schreger in 1825 On the whole, English writers have called it "tennis-elbow" while Continental authors have preferred "epicondylitis." The former name is preferable, since in by no means every tennis-elbow does the lesion lie at the epicondyle.

CLINICAL CONSIDERATIONS

Pain is referred from a tennis-elbow for a variable distance along the forearm, usually at least as far as the mid-part of its postero-lateral surface. It may reach the dorsum of the wrist or hand. If it travels to the fingers the long and ring fingers are nearly always the ones picked out (seventh cervical segment). Rarely the ring and little fingers hurt although no structure forming part of the eighth cervical segment is affected in tennis-elbow. Occasionally, the pain spreads upwards and is felt only in the arm.

The symptoms are the same whichever type of tennis-elbow is present The patient notices a slight transient ache in his elbow one day, often after tennis or after repeatedly extending his wrist during some other occupation such as chopping with an axe, fly-fishing, scouring pans or bricklaying. This passes off, but a few days later, when the patient uses his forearm again, the pain is more annoying.

Within two or three weeks the patient finds that he cannot take a backhand stroke at all. He may also describe sudden twinges; he lifts, say, a teacup and a sudden access of momentary pain and powerlessness makes him drop it. If he is over sixty years of age, the onset may be very gradual and connected with the patient's occupation, *e.g.* using a hammer.

Spontaneous cure in patients with teno-periosteal tennis-elbows takes a year if the patient is under sixty, two years if he is older. The other uncommon varieties do not show this tendency to spontaneous cure and often last indefinitely. The teno-periosteal type occurs, in my experience, only once in a patient's lifetime; at any rate those who recover from it have been reported not to suffer any relapse for up to twenty-five years, even when they return to the occupation that produced the condition in the first place (Cyriax, 1936).

EXAMINATION

Whatever the type of tennis-elbow, examination discloses that (a) passive movement of the elbow is of full range and painless, (b) the resisted movements of the elbow are of full power and painless, (c) the pain at the elbow is reproduced on resisted extension but not resisted flexion at the wrist In the ordinary teno-periosteal variety the pain is such that the patient often winces and lets his hand flex when asked to extend it vigorously against resistance he may feel a twinge with momentary involuntary loss of power Further examination shows that resisted radial deviation hurts but ulnar deviation does not. If the fingers are flexed actively so that the extensor digitorum is thrown out of action, the extension movement at the wrist still hurts In this way it can be proved that the only muscles at fault in tennis elbow are the extensores carpi radialis

The two facts that warn the examiner that one of the unusual sorts of tennis-elbow is present are (1) no wince, the patient being able to hold his wrist extended against strong resistance feeling pain insufficient to make the muscles give way, (2) a history lasting longer than a year in a patient under sixty years of age

Palpation

There are five types of tennis-elbow, distinguishable only by the exact site of tenderness disclosed by palpation. Only the teno-periosteal variety is common. In eight out of ten cases the lesion in the extensor muscles lies at the origin of the common extensor tendon from the periosteum at the lateral epicondyle of the humerus The other situations are, in order of frequency (1) the upper part of the bellies of the extensores carpi radialis (one in ten), (2) the tendon at the radio-humeral joint line (one in twelve) (3) the musculo-tendinous junction (one in a hundred) (4) the supracondylar origin of the extensor carpi radialis longus muscle (one in a hundred)

After the fact that resisted extension of the wrist hurts at the elbow has been established, the site of the lesion in the relevant muscle must be ascertained. To this end, palpation

is carried out with careful comparison with the other side throughout. Palpation includes the teno-periosteal junction at the front of the epicondyle, the tendon just above the radio-humeral joint line, the musculo-tendinous junction level with the head of the radius, and the upper belly just below this point. When palpation here is carried out, the brachio-radialis muscle lying superficially must be avoided, hence the examiner's fingers must squeeze the extensor belly deeply *in the manner shown in Fig 46.* If no tenderness is found anywhere here either—a most unusual result—tenderness should be sought at the supracondylar origin of the extensor carpi radialis longus muscle.

Double lesions can occur in tennis-elbow; the findings on

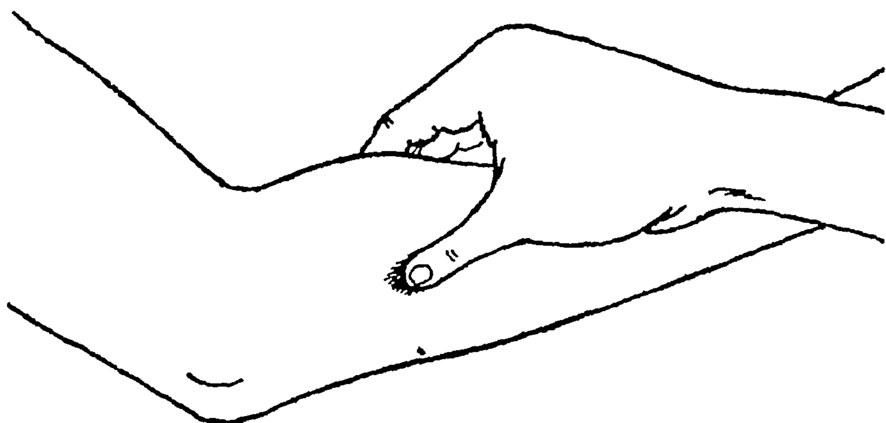


Fig. 46—Palpation of the bellies of extensor muscles in upper forearm Since pressure of the muscle bellies against the radius is normally painful palpation must be carried out in the manner shown

palpation are then very difficult to interpret and the induction of diagnostic local anæsthesia may become imperative. Alternatively, the more obvious of the two lesions can be treated and the forearm examined again when this has been dealt with.

It should be remembered that, in cases of the teno-periosteal variety, associated tenderness (see p. 117), of the type well recognized in "Styloiditis radii," may be found at the *back* of the lateral humeral epicondyle. Since the patient's pain is elicited by a resisted extension movement at the wrist and no part of this extensor mechanism is attached to the posterior aspect of the epicondyle, tenderness here represents no relevant lesion

The radiograph reveals no abnormality in cases of tennis-elbow

PATHOLOGY OF TENNIS ELBOW

The muscular and musculo-tendinous types are examples of ordinary overstrain such as may occur anywhere. On the other hand, the far commoner teno-periosteal type is an injury to which no complete parallel exists in the rest of the body A considerable body of evidence has been brought forward (Cyriax, 1936) to show that the usual lesion is a tear between the common extensor tendon and the periosteum of the lateral humeral epicondyle. Examination of the resisted wrist movements shows clearly that the muscle that is painful on use is one of the radial extensor muscles of the wrist. Since the tenderness is at the epicondyle, the fault cannot lie at the origin of the long extensor muscle, which is attached higher up, hence the tear lies at the origin of the extensor carpi radialis brevis muscle In the early stages, just as often as the tear begins to unite, so often does the patient, by using his hand, pull the healing surfaces apart again The result, as might be expected, is that a painful scar forms at the teno-periosteal junction.

The onset of a tennis-elbow is always slow This shows that the minor tear in the tendon is not, of itself, a source of appreciable pain It is only when endlessly repeated attempts at union have been broken down during daily use of the hand that the painful scar appears and causes the symptoms This view was expressed by myself in 1936, McKee (1937), operating on cases of tennis-elbow, confirmed this finding

Spontaneous cure appears to result, in the common teno-periosteal type, from a gradual widening of the gap in that part of the tendon corresponding to the extensor carpi radialis brevis muscle. Finally this small tear parts completely and cure results, the rest of the tendon now taking the strain Since several muscles are attached here, slight permanent lengthening of the section of tendon relevant to *one* muscle does not weaken the power to control the wrist, by contrast it has the happy effect of a slight lasting structural lengthening preventing recurrence

TREATMENT

The different types of tennis-elbow need different treatment This fact is by no means widely accepted, all cases of tennis-elbow being regarded as treatable in the same way, wherever the lesion in the muscle lies.

1. *Teno-periosteal Variety*

This is the common site, and no less than seven methods exist for its relief, but only the first four mentioned below are, in my opinion, worth serious consideration.

The underlying principle is to obviate painful tension between the tendon and the periosteum. This can be achieved in two ways—namely, by placing the two edges of the tear in apposition so that they can unite, or by separating them completely. The second method is called for much more often and imitates the mechanism of eventual spontaneous cure. In all cases patients are treated until resisted extension of the wrist becomes painless.

Before treatment is begun, the patient, if less than sixty years old, should be told that spontaneous cure without treatment is highly probable within a year. He may, if he knows this, prefer merely to wait, sparing his elbow as much as possible meanwhile.

(*a*) *Cock-up Splintage.* Distraction by muscle pull of the two edges of the tear can be prevented by immobilization of the wrist (not the elbow) in full extension in a splint or in a plaster cast; the elbow must not be included. This treatment is worth a trial if the history is short, say a month or less. The plaster splint should be retained until attempted extension of the hand against the resistance of the cast is painless. If this is not being achieved by the end of two months, the immobilization is hardly worth persevering with. The only theoretical objection is that, since healing occurs without any permanent lengthening, the patient may develop a tennis-elbow again later. This is a matter of some importance to professional tennis-players.

Cock-up splintage is sometimes called for in the treatment of tennis-elbow in patients so neurotic that they cannot stand active measures. Another alternative in such cases is ultra-sonic waves.

(*b*) *Friction and Manipulation* This is the treatment of choice. It acts by separating the two edges of the tear and thus ensuring that tension on the painful scar in the breach is obviated, the intact part of the tendon taking all the strain The section of tendon corresponding to the extensor carpi radialis brevis is lengthened and thus spared from transmitted stress, this is permanent and accounts for the fact that recurrence is almost unknown

Apart from reduction of a displaced loose body, a teno-periosteal tennis-elbow provides the only indication for manipulating the elbow The best method is that described by Mills in 1928 It exerts a sudden strong pull on the tendon, converting a tear shaped like a V into separation of the torn surfaces, *i.e* a ⊔ (see Vol II) This manipulation is performed two or three times a week until the patient is well—some four to eight sessions may be required Analgesia should be supplied by deep friction administered to the anterior aspect of the epicondyle first for some ten or fifteen minutes. Properly done, this massage has the further advantage of softening the scar tissue that the manipulation proposes to rupture. Local anæsthesia is not recommended for when induced at the epicondyle two days' severe pain follows, thus setting up more discomfort than it avoids

General anæsthesia is contra indicated Indeed, under pentothal anæsthesia, the manipulation can be carried out only during an induced contraction of the extensor muscles by faradism. Unless the muscles retain their tone, a proper pull on the tendon is not exerted, hence full muscular relaxation has to be avoided. Nitrous oxide anæsthesia carried to the point of unconsciousness but not of relaxation of muscle is satisfactory However Mills's manipulation is over so swiftly that it is best carried out without analgesics, moreover, it has often to be repeated several times and few patients care to accept repeated anæsthesia

Mills's manipulation must in no circumstances be performed unless extension at the elbow is of full range and painless The physiotherapist must make sure that this remains so at the patient's each attendance for Mills's manipulation, imperfectly performed (*i.e* with the patient's wrist not held fully flexed throughout), may lead to a slight traumatic arthritis

at the elbow. If the joint is rested for a week or two, it recovers, and treatment can safely be begun again, whereas immediate repetition of the manipulation can set up serious trouble. If osteo-arthritis, a loose body in the joint or traumatic arthritis limit extension at the elbow, Mills's manipulation is out of the question and one of the alternative measures set out below must be employed.

Another manipulation also having the effect of stretching the outer side of the joint was described by me in 1936; it is not so effective as Mills's, though it cures less painfully when it does succeed (see Vol. II).

(c) *Faradism.* The extensor carpi radialis brevis is picked up with faradism and the elbow held as extended as possible and the wrist flexed. A strong tetanic spasm is then induced by pushing the core home. Four times is as much as most patients will endure at each session.

This method is suited to cases in which manipulation is contra-indicated because of limitation of extension at the elbow-joint.

(d) *Ultra-sonic Waves.* These can be used for their mechanical effect in breaking up fibrous tissue. Except when the lesion lies in the muscle belly, any resistant tennis-elbow can be treated by these waves—in particular, the tendinous variety.

(e) *Operative Division.* Tenotomy and open division at the epicondyle have been practised, not always with such uniformly good results as might have been expected. The operation is presumably less likely to succeed if the tendon is divided not at the tear, but to one or other side of it. I have only slight personal experience of tenotomy and have seen its failures but not, of course, its successes.

(f) *Injection of Fluids.* The introduction of fluid between the bone of the lateral epicondyle and the periosteum may raise the latter off the bone and thereby relax the tension on the common extensor tendon. In spite of repeated attempts, I have never yet improved a patient by this means, except for the duration of anæsthesia. Considerable after-pain lasting about two days is to be expected. Nevertheless, other practitioners have reported good results and the method at least appears to me reasonable. A suitable solution is 1 per cent procaine in normal saline, in amounts not exceeding

5 c.c. Proctocaine (1 c.c.) has been recommended It has an occasional success, but the severe after pain going on for three or four days is a real drawback.

(g) *Self manipulation under Local Anæsthesia* The patient can be made to manipulate, as it were, his own elbow, local anæsthesia being induced at his lateral epicondyle and the patient then practising backhand strokes during the next hour According to the literature, this has resulted in cure, but considerable after pain must be expected when the anæsthetic effect wears off

2 *Muscular Variety*

Local anæsthesia is the treatment of choice. Even though the patient may have had pain for five or ten years, two to four weekly injections into the right spot are nearly always lastingly curative.

The great difficulty is to infiltrate the right spot. The tender area in the belly lying deep to the brachio-radialis is identified. The art is to put the whole 10 c.c. syringeful of 0 5 per cent procaine solution into the exact spot. Given in this way, the injection exerts a strong hydraulic effect, bursting as it were, the muscle-fibres apart. The resisted movement is tested some minutes later if it is not quite painless, the right spot has not been infiltrated Should the adhesions between the muscle fibres resist hydraulic mobilization, deep massage has to be substituted. This is difficult to give and very painful to receive, but no alternative exists (see Vol II) Manipulation is a waste of time

3 *Tendinous Variety*

The lesion lies in the body of the tendon, about an eighth of an inch below the teno-periosteal junction Usually friction and manipulation as for the common sort of tennis-elbow suffices, though rather more (up to ten or twelve) repetitions are called for

Should this fail, ultra sonic waves are usually effective, but treatment three times a week has usually to be continued for two or three months.

4. *Other Varieties*

If the lesion lies at the musculo-tendinous junction, local anæsthesia can be used in diagnosis but is useless in treatment. Deep massage alone is curative Failing this, the symptoms continue indefinitely. When the origin of the extensor carpi radialis longus above the epicondyle is at fault, two or three treatments by deep massage cure, however many years the symptoms have lasted. This is the easiest tennis-elbow to cure; unfortunately it is so seldom encountered.

HYDROCORTISONE IN TENNIS AND GOLFER'S ELBOW

The local anti-inflammatory effect of hydrocortisone is seen at its best in these two conditions In teno-periosteal or tendinous tennis-elbow, or in either variety of golfer's elbow, a painful scar exists, the position of which can be determined precisely and infiltrated with full accuracy. Hydrocortisone became available to me only early in 1953 but my experience during that year makes it clear that the treatment of choice at the common extensor or flexor tendon is immediate infiltration with 0·5 c.c of the suspension. This has now been tried on over a hundred patients with these types of tennis-elbow, nearly all of whom were rendered pain-free and able to resume tennis ten days after the injection. Some 20 per cent recurred after several months' freedom since the first injection and needed another Five per cent were complete failures. Many cases of golfer's elbow were likewise cured, but one case proved intractable

After the injection, which has no immediate analgesic effect, there is two days' considerable soreness, at the end of a week or ten days the patient is well. During these few days he is asked not to exert his wrist, so that the anti-inflammatory effect of the hormone may be exerted in a favourable environment.

If this method of treatment gives as permanent a result as now seems likely, the methods described in paragraph 1 and 3 above, and under "Golfer's Elbow" below, will shortly be out of date, and employed only for the 5 per cent intractable by hydrocortisone.

GOLFER'S ELBOW

This is a lesion of the common flexor tendon at the medial epicondyle. In the right handed golfer's elbow occurs at the right elbow in those who play golf at the left elbow the lesion produced by golf is a tennis-elbow Again, those who play tennis with a strong forehand drive can develop a golfer's elbow and both disorders affect those who play neither game The names are useful as indicating the condition present but they should not be given ætiological weight.

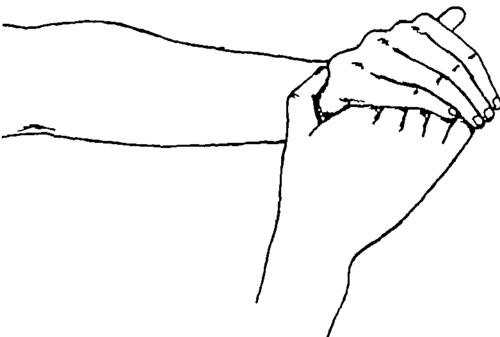


FIG 47.—Resisted flexion at wrist. The patient flexes his hand at the wrist *against the resistance of the examiner's hand.* The elbow is kept extended.

The names are justified only historically, the conditions having been first described as affecting players of the respective games

Golfer s elbow is less common than tennis-elbow It is also simpler for there are only two varieties Moreover *only one sort of treatment is* indicated Spontaneous cure seldom takes place untreated the condition grumbles on for years

The signs are

1 A full range of painless movement is present at the elbow

2. All resisted movements at the elbow are painless
3. Resisted flexion, but not extension, of the wrist sets up pain at the elbow. Rarely flexion of the fingers rather than of the wrist elicits the symptoms best.

There are two varieties, distinguished by the site of tenderness. This is found either at the epicondyle (teno-periosteal junction) or at the musculo-tendinous junction a quarter of an inch distally.

Adequate massage to the right spot does not fail if the lesion is less than five years old, and often succeeds even in cases of longer standing than that (see Vol. II) Manipulation is useless. If a case resistant to friction were encountered, ultra-sonic waves would appear the obvious treatment to try next, if hydrocortisone is not available.

It should be remembered that though pain in the forearm alleged to occur on both flexion and extension of the wrist is usually of psychogenic origin, secondary deposits in the radius or ulna also have this effect.

ISCHÆMIC CONTRACTURE

Permanent contracture (Volkman) of the flexor muscles of the forearm results from persistent spasm of the brachial artery complicating a supra-condylar fracture of the humerus The elasticity of the muscle-bellies is largely lost and extension of the fingers remains possible only after the wrist has been flexed—the constant length phenomenon. Resisted flexion of the fingers does not hurt.

If the radial pulse is lost after a fracture at the elbow, and does not return when the patient is warmed, the artery should be exposed and painted with papaverine (Kinmonth, 1952)

THE WRIST-JOINT

The evidence obtained when the passive movements of the wrist are tested is open to a misconstruction A movement that might be regarded as relaxing the tendon in fact pushes it down its sheath; hence the examiner must be on his guard against misinterpretation of pain elicited in this way.

One of the classical signs of teno-synovitis is *crepitus*; in acute cases this can be felt easily, not only where the tendon has a sheath but, curiously enough, as high as the upper part of the forearm. On the other hand, crepitus will hardly ever be felt in chronic teno-vaginitis unless the cause is tuberculosis or advanced rheumatoid arthritis. Crepitus does not have to be sought; when present it obtrudes itself, but its absence provides no evidence that the tendons are normal.

A small myxomatous tumour, known as a ganglion, often forms at the dorsum of the wrist; it may be connected with the wrist-joint itself or with the overlying tendons. If the ganglion has a thin wall, it can often be burst by digital pressure; failing that by puncture with a thick needle followed by expression. Recurrence is unusual after this simple treatment. However, should the ganglion form again, 1 c.c. of ethamolin should be injected into it on two or three occasions at weekly intervals. Excision, surprisingly enough, may also be followed by recurrence, hence treatment by sclerosing injection is to be preferred. Multiple ganglia are common in advanced rheumatoid arthritis; they do not require treatment.

PASSIVE MOVEMENTS AT THE WRIST

Flexion, extension and ulnar and radial deviation must each be tested. Limitation of movement in each direction indicates arthritis; limitation in one direction only suggests a persistent carpal subluxation. The following disorders occur:

1. *Traumatic Arthritis*

In my experience, this does not occur in the absence of a

carpal fracture. I have never seen a case of simple traumatic arthritis lasting more than a day or two

The clinical diagnosis of carpal fracture is extremely easy as a rule, whereas the appearances on the radiograph taken soon after the injury may reveal no change. The history is of a sprain affecting the wrist and is seldom distinctive Inspection reveals the whole wrist to be swollen. Passive flexion and extension movements are limited by muscular spasm and the diagnosis of traumatic arthritis thus established The patient should be asked on which side of the wrist he feels his pain. If a passive deviation movement towards the painful side hurts more than that away from this side, it is clear that squeezing the carpal bones together causes pain for such a movement relaxes all other structures in the neighbourhood. Palpation for the site of tenderness shows which of the bones has been damaged The two bones most often fractured are the scaphoid and the cuneiform, the latter usually has only a flake chipped off it. Even so, the above signs are constantly present and are more reliable in pointing to the diagnosis than the radiograph taken immediately after the accident, though one taken a few weeks later rarely fails to reveal the damage to bone. Fractures of the scaphoid bone require treatment by immobilization at once, hence, when the above signs are elicited, a plaster cast should be applied at once and a second radiograph taken a fortnight later for confirmation.

2 *Rheumatoid Arthritis*

This is common In addition to the limitation of movement the joint is visibly swollen, warm to the touch and the joint capsule is the site of much soft thickening The chronic stage may progress to virtual ankylosis in slight flexion the swelling then remains but the local warmth disappears The disorder usually affects both wrists, often after the fingers have become affected. Except in the most chronic stage, the blood sedimentation rate is greatly raised. Gout and gonococcal arthritis must be excluded.

In the acute stage, immobilization of the wrist for some weeks by an elastoplast bandage or a cock up splint is indicated if pain is severe. Hydrocortisone is usually very

manipulative reduction is accompanied by a click and the immediate restoration of full painless range, and (c) there is a liability to recurrence, there is no other possibility It has been argued that the manipulation ruptures an adhesion but what adhesion placed at the dorsum of the joint can limit extension, and how can an adhesion, once ruptured lead to recurrence? The displacement is clearly very slight and, since the bones on the lateral radiograph of the wrist in any case vary in position according to slight changes in the position of the hand on the forearm, minor deviations cannot certainly be detected

Manipulative reduction is easy to perform and, in these minor displacements, does not fail (see Vol. II) If the subluxation has been present for several months some of the ligaments about the capitate bone remain strained and, though a full range of movement is restored at once, the extremes of one or two movements remain painful. One or two sessions of adequate deep massage are then lastingly curative.

Two other conditions give rise to solitary limitation of extension at the wrist, but both show clearly radiologically They are Keinboch s disease (aseptic necrosis of the lunate bone) and isolated osteo-arthritis at the lunate-capitate joint. In the former case, sclerosis and deformity of the lunate bone are obvious on the x ray photograph in the latter, localized disappearance of articular cartilage (seldom with osteophytes) is seen.

5 *Ligamentous Sprain*

There are several different sites

Ulnar Collateral Ligament. This follows imperfect reduction of a Colles's fracture, and may be associated with fracture of the styloid process of the ulna Inspection reveals the characteristic deformity and examination of the passive movements at the wrist shows that only radial deviation hurts Spontaneous cure takes a year deep massage, adequately given abolishes the symptoms in a month so does an injection of hydrocortisone

Radial Collateral Ligament Sprain here is very rare and is characterized by pain felt only on the extreme of passive ulnar deviation. In fact, the condition usually present when

a sprain here is thought to exist is teno-vaginitis of the thumb tendons at their carpal extent (see p. 296). Trial of the resisted movements prevents error. Deep massage is effective.

Lunate-capitate Ligament. This is common, and may occur without subluxation at the joint; alternatively, it may persist after a subluxation of some months' standing has been reduced. The sign is pain felt at the dorsum of the wrist at the extreme of flexion, all the other passive movements proving of full range and painless. Search for tenderness reveals the exact site of the sprain. Deep massage, properly given, is always curative in a few weeks, even if the condition has persisted (as it often has) for several years.

Great difficulties attend differential diagnosis between a severe sprain of this ligament and a minor degree of bony subluxation at the lunate-capitate joint. In a doubtful case, no harm is done by an attempt at reduction, followed at once, if there is nothing to reduce, by deep massage.

Occasionally other ligaments are sprained; perhaps the radio-lunate, the capitate-third-metacarpal or the ulnar-triquetral (cuneiform). The site of tenderness is always carefully sought, the examiner keeping in mind that these sprains are often multiple and thus continuing his search even after the most obvious spot has been found. This is vital; for unless all the sprained ligaments are given adequate massage, the patient is condemned to a permanently troublesome wrist. This may prove economically crippling to a musician, a surgeon, a professional golfer or tennis-player, or a physiotherapist.

Chronic ligamentous sprain at the wrist differs from that at other joints in that forcing movement, with or without anæsthesia, is powerless to rupture post-traumatic adhesions. The scar can easily be mobilized by deep massage; all other methods are of no avail. When manipulation failed, many months' immobilization in plaster, even operation, had already been carried out in some of our cases; but such previous treatment did not prevent massage from rapidly bringing about recovery.

A sprained ligament at the wrist, recent or long-standing, calls for (*a*) immediate diagnosis detailed enough to inform the physiotherapist exactly where and in which direction to apply her friction, and (*b*) a physiotherapist trained to give

accurate massage. Much permanent disability will be avoided when deep massage is adopted as the treatment of choice for ligamentous lesions at the wrist, and physiotherapists are trained to give it.

6 *Ligamentous Rupture*

This follows a severe flexion injury and leads to permanent slight instability of the wrist. The ligament that usually ruptures is the capitate-third metacarpal a depression can be palpated at this point on full wrist flexion The pain is usually considerable for the first fortnight if so immobiliza tion in plaster is required at once. After a month, the symp toms have ceased, but recur if the patient exerts the wrist much. Care and a wrist-strap are called for, but some weak ness always persists for the ligament does not unite and cannot be reconstituted by surgery Massage is useless

RESISTED MOVEMENTS AT WRIST

Extension, flexion, radial deviation and ulnar deviation at the wrist are all tested against resistance, with the elbow held in extension If this condition is not observed, false nega tive responses may be elicited in cases of golfer s or tennis elbow The resisted thumb and finger movements follow (see p 295 and p 300) since the thumb tendons also move the wrist, and the interosseous muscles if damaged proximally cause pain at the wrist.

Pain felt on movement resisted at the wrist may be felt in two places—at the elbow or at the wrist. This differential localization by the patient indicates correctly where the lesion lies. If the pain is felt in the upper forearm or lower arm a golfer s or a tennis-elbow is present (see Chapter XII) If one, or two, congruous movements cause pain near the wrist, a tendinous lesion is present.

Pain on Resisted Extension

If the pain is felt at the wrist, the extensor tendons of the wrist, seldom of the fingers, are affected Crepitus is occasion ally felt when the carpal extent of the extensor indicis muscle

is involved. If the fingers are kept flexed voluntarily, the extensor digitorum longus muscle is thrown out of action; now, should the resisted movement towards extension still hurt, the carpal extensors are involved. Whether resisted radial or ulnar deviation hurts indicates whether the extensores carpi radialis or the extensor carpi ulnaris is involved. In the former case, the lesion is sought with the wrist held in full flexion and will be found to lie at the insertion of the tendons into the bases of the second and third metacarpal bones (sometimes one, sometimes both). This is a pure teno-periosteal strain, therefore incurable by any operation slitting up the tendon-sheath; there is no teno-vaginitis or teno-synovitis. If the extensor carpi ulnaris tendon is at fault, the lesion has by contrast three possible sites, identified by discovery of the site of tenderness while the wrist is held in full radial deviation: at the base of the fifth metacarpal bone (teno-periosteal); at the extent of tendon between the triquetral (cuneiform) bone and the ulna; at the groove in the lower extremity of the ulna It is when the tendon is affected in this groove that the puzzling phenomenon occurs of pain elicited at the extreme of passive supination of the forearm.

Deep massage is always swiftly curative whatever the site of the tendinous lesion, even if the disorder has resisted every other treatment and has gone on for years. The only contra-indication to massage is rheumatoid, tuberculous or gonorrhœal teno-vaginitis.

Weakness on Resisted Extension

When testing resisted extension at the wrist reveals painless weakness, the strength of this movement at the other limb must be compared.

Bilateral weakness confined to the extensor muscles at the wrists suggests lead poisoning. If this is shown not to be a factor, carcinoma of a bronchus should be suspected. In my experience, this has provided an early sign at a time when a straight radiograph of the lungs as yet reveals nothing and no evidence of spinal metastasis can be found. A cough, the beginnings of a hoarse voice or thoracic discomfort in association with this weakness strongly suggest a pulmonary neoplasm.

Unilateral weakness occurs in (*a*) Radial pressure palsy from *e.g.*, a crutch or the edge of a chair impinging on this nerve in the arm, or a fracture of the humerus at mid shaft. (*b*) Sixth or seventh cervical root palsy In the former case, the flexors of the elbow lose power too in the latter, the triceps and wrist flexor muscles are much weakened

Pain on Resisted Flexion

If the pain is felt in the lower forearm, the flexor tendons of the wrist or of the fingers are at fault. Resisted flexion of each finger and resisted radial and ulnar deviation are all tested, and the affected tendon thus singled out. When the flexor digitorum profundus is affected, the tender extent is usually 1½ inches long and in the lower forearm When the flexor carpi radialis is affected, the whole distal extent of the tendon is usually tender, sometimes including the teno-periosteal junction at the base of the second metacarpal bone. When the flexor carpi ulnaris is affected, tenderness must be sought at two sites the extents proximal to and distal to the pisiform bone. In the latter instance, deep palpation through the thickness of the hypothenar muscles is required. Adequate deep massage quickly cures (see Vol. II)

Rheumatoid Teno-vaginitis This disorder is apt to involve one flexor tendon near the carpus During the first few weeks the only distinguishing feature is diffuse swelling and local heat palpable at the front of the forearm, combined with tenderness over an extent of tendon greater than is to be expected in cases due to overuse Within as a rule a month, the swelling resolves into a series of nodules on the tendon sheath local heat persists. The treatment is one or two infiltrations with hydrocortisone, which appears to afford lasting quiescence. Even giving deep massage within a few weeks has not led to recurrence Arthritis of the fingers does not supervene, at any rate for the next two years.

A swelling similar to that causing trigger finger, sometimes forms at a flexor digitorum tendon in the lower forearm This sets up pressure on the median nerve where it passes under the transverse carpal ligament and is one of the causes of the carpal tunnel syndrome (see p 299)

Foreign-body Teno-synovitis An uncommon cause of

tendinous trouble at the wrist is movement of a foreign body embedded in the forearm. Even after many years—the longest period that I have so far encountered was thirty-two years—a small fragment of metal, *e.g.* lead shot or shrapnel, may suddenly work its way out of the fleshy mass of muscle in which it has lain and in the course of some hours or a day move down and lodge at the wrist. Crepitating teno-synovitis results here. This condition should be suspected if the forearm is scarred and the patient believes that fragments of metal remain. The position of the foreign body should be identified by palpation. It is then pushed downwards by the examiner's fingers. When it has reached the middle of the palm, it disappears; it can no longer be felt by the physician and it ceases permanently to trouble the patient further.

Weakness on Resisted Flexion

This finding indicates a seventh cervical root-lesion and is associated with marked loss of power in the triceps muscle. The triceps jerk is seldom sluggish.

An eighth cervical root-palsy leads to weakness of both the ulnar deviators of the wrist. In such a case during the resisted flexion movement, the hand is seen to deviate radialwards. Corroboration is found in associated weakness of the muscles controlling the thumb.

THE THUMB

Since both arthritis and teno-vaginitis at the thumb give rise to pain felt at the wrist, no examination of the wrist is complete without a study of the passive and resisted movements at the first carpo-metacarpal joint.

A small thumb since birth may indicate a congenital deformity at the lower cervical spine of the Klippel-Feil variety.

PASSIVE MOVEMENTS

Four passive movements should be tested at the trapezio-first-metacarpal joint: flexion, extension, abduction and

backward movement during extension. Pain felt at all extremes of range indicates arthritis, limitation of movement is confined to abduction. Since the anterior aspect of the capsule of the joint is that most affected, the movement found to hurt most is backwards during extension Tenderness is also most obvious at the front of the joint. In osteo-arthritis crepitus can usually be elicited by pressing the bones together and moving the first metacarpal bone to and fro over the trapezium. The radiograph shows the condition clearly It is often bilateral, sometimes in association with osteo-arthritis of the fingers In traumatic arthritis the x ray photograph reveals no abnormality, pain may go on for months

Massage to the capsule of the joint cures traumatic arthritis within a fortnight or so, it relieves the pain in not too advanced osteo-arthritis, but recurrence sooner or later must be expected (see Vol II) In severe osteo-arthritis, non-operative treatment is of no avail.

RESISTED MOVEMENTS

Arthritis at the carpo-metacarpal joint may be simulated by teno-vaginitis at the base of the thumb for the passive movements slide the tendon up and down within its sheath, thus setting up painful friction. Hence there is often pain on some of the passive thumb movements but, when the resisted movements are tested, some of these are found to hurt too thus incriminating the tendons

Pain on Resisted Extension

This is associated with pain on resisted abduction, resisted flexion and adduction proving painless (see Fig 48) The pain may be felt only in the lower forearm, if so, the abductor longus and extensores pollicis tendons are affected where they cross the shaft of the radius just above the wrist. Crepitus is present in recent cases the tendons are tender over an extent of 1½ inches. If the pain is felt diffusely, radiating down to the thumb and up the forearm the tendons of the extensor brevis and abductor longus are probably affected at their carpal extent. If so, crepitus is absent, but a localized thickening can be seen at the radial side of the wrist and there

is a small area of great tenderness at the radial styloid process. This is an example of the phenomenon named by me "associated tenderness." The bone is more tender than the tendon itself, though this area of bone has no connexion with the tendons. When the teno-vaginitis ceases, the bony tenderness ceases too; so they must be cause and effect. Tenderness of the

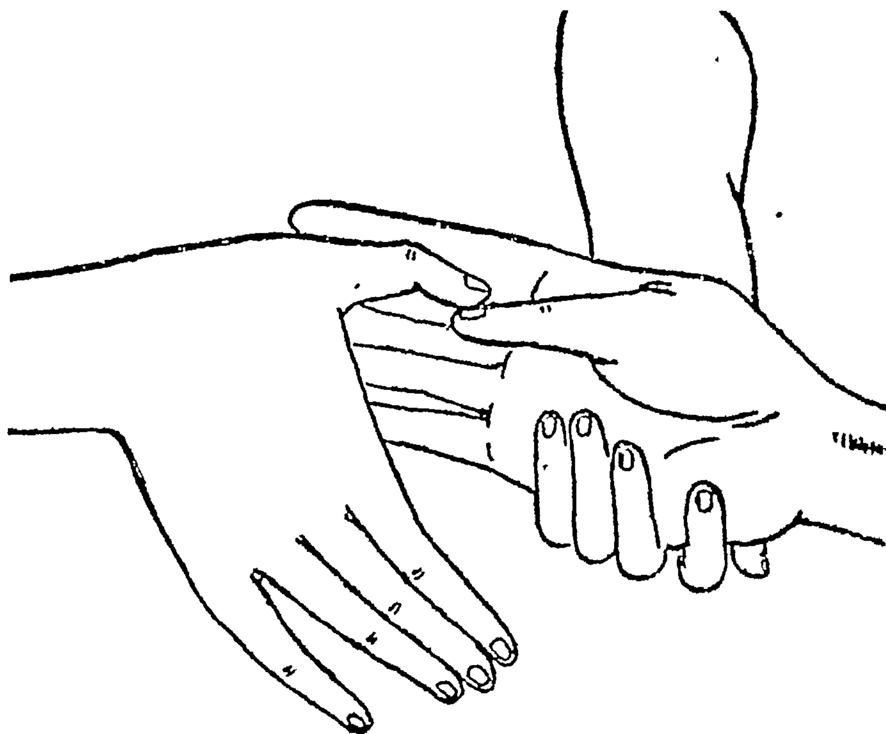


Fig. 48.—Resisted extension of thumb While the patient's hand is held steady, he presses his thumb upwards against the examiner's thumb.

abductor longus and extensor brevis tendons in their common sheath must be sought in three places: (1) at the level of the carpus; (2) at the insertion of the abductor longus into the base of the first metacarpal bone; (3) at the groove on the base of the radius. It is most important to decide at which points the tendons are involved—one, two or all three places—otherwise the physiotherapist is in immediate difficulties.

The extensor longus pollicis is very seldom affected. If it is found tender at its carpal extent, whereas the extensor brevis and abductor longus tendons are not; cure by massage is easy and takes about a fortnight.

"*Styloiditis Radii.*" Sometimes the pain at the styloid process is so noticeable that the patient volunteers the infor-

mation that his wrist is painful and tender at that point but does not mention pain on moving the thumb The case is then very puzzling unless the relationship of an abductor and extensor teno-vaginitis of the thumb to tenderness of the styloid process is kept in mind When associated with pain on resisted extension and abduction movements of the thumb tenderness at the styloid process merely indicates that the carpal extent of the tendons is at fault no lesion at the actual process appears present. The condition has been described under the misnomer of "styloiditis radii", this is putting the cart before the horse, for the teno-vaginitis is the primary lesion and the bony tenderness will not go until the tendons recover

Treatment. Only three methods are worth considering, for immobilization in plaster has such poor results even after many months that it is mentioned only to be condemned. I have seen patients still in severe pain after a year in plaster (1) *Operation* If the sheath common to the extensor brevis and abductor pollicis longus is slit up the tendon and its sheath no longer fit tightly As a result, teno-vaginal friction—and therefore pain—ceases immediately Indeed, the patient comes to from the anæsthetic cured (2) *Hydrocortisone* One or two injections usually suffice to cure, and is effective in nine cases out of ten. The affected tendons are identified, the thumb held flexed and the wrist deviated ulnarwards The needle is introduced from close to the base of the thumb and passed proximally until resistance to its passage ceases as the space between sheath and tendon is reached One c.c. of hydrocortisone is injected The immediate reaction is slight and the patient usually well a week later (3) *Massage* Though the swelling of the tendon might well be regarded as contra indicating massage, this is nevertheless an effective cure but it takes three months It hardly ever fails, however and is the method of choice for those few intractable by hydrocortisone or attending any hospital where the orthopædic waiting list for admission is more than two months long The massage must be administered over the *whole* of the affected area if one affected part is omitted by the physiotherapist, the condition does not recover Where the tendon is treated it gets well where not, not hence the importance of ascertaining the precise extent of the teno-vaginitis.

Rheumatoid Teno-vaginitis. This may occur at the extent of the abductor longus and extensor brevis tendons. As a rule, the wrist- or finger-joints are affected, but occasionally the marked soft swelling tendon-sheath provides the first sign. The gross thi contrasts with the slightness of the symptoms, thus guishing the disorder from that described above, wh pain and disability are far greater than might be ex from the minor signs. Treatment by one or two inj with hydrocortisone is successful and recurrence u When unilateral rheumatoid teno-vaginitis occurs isolated phenomenon there appears to be no pa tendency to later supervention of rheumatoid arthriti

Pain on Resisted Flexion

Pain felt when this movement is tested by res exerted at the distal phalanx shows the flexor pollicis tendon to be at fault. If it is affected at its met extent, all treatment is ineffective but spontaneous re takes six to twelve months, depending how much the p can spare his thumb. If the tendon is affected at the crepitus is sometimes palpable and the ordinary tre by deep friction swiftly effective.

Trigger-thumb. A swelling on the flexor pollicis tendon may become engaged in the tendon-sheath active flexion of the thumb. If so, the patient cannot tarily extend his thumb again, the thumb being fi flexion at the interphalangeal joint. He straighte thumb by using his other hand; there is a snap, and ment is restored. The swelling can be felt moving u down as the patient moves his thumb; it lies just pr to the head of the metacarpal bone.

Acupuncture has an occasional success, not always p nent. If this fails and the symptoms warrant, a small operation slitting up the tendon-sheath longitudinally region of the swelling affords immediate and lasting

Weakness of the Thumb Muscles

Weakness of abduction and extension of the thumb c terizes a disc-herniation at the seventh cervical level

consequent eighth root palsy It is associated with weakness of ulnar deviation at the wrist, and is occasionally permanent

Weakness of abduction is not perceptible even when the abductor pollicis brevis muscle is markedly wasted as the result of a cervical rib compressing the lower trunk of the brachial plexus Wasting without apparent weakness of the thenar muscles is a rare complication of the carpal tunnel syndrome (see p 299)

Weakness results, of course, when a tendon ruptures, this is usually obvious. Rupture of the extensor longus pollicis is an uncommon complication of fracture at the lower end of the radius. After a Colles's fracture, the tendon may become frayed by the bony irregularity at the fracture line, finally parting during as a rule, the second month. The treatment is surgical.

Ischæmic contracture may affect the belly of the flexor longus pollicis muscle, if so the matacarpo-phalangeal and the interphalangeal joint can each be extended singly but not simultaneously—an example of the constant length phenomenon causing the extra articular type of limitation of movement (the amount of movement obtainable at one joint depending on the position in which an adjacent joint is held)

Treatment. When the abductor and extensor muscles of the thumb are paralysed (usually as the result of anterior poliomyelitis) but the flexors are spared, a simple device will be found helpful. A small triangular sponge-rubber cushion is fashioned for the first interdigital cleft. Rubber of resilience commensurate with the strength of the patient's flexor muscles is selected The cushion is held in place by a band about the wrist. When the patient relaxes his flexor muscles, the thumb moves back into extension.

If this measure does not suffice, a tendon transplantation or an arthrodesis may help

CARPAL TUNNEL SYNDROME

Pressure on the median nerve near the wrist was briefly discussed in a paper (Cyriax, 1942) in the *British Medical Journal* under the heading "median perineuritis" I mentioned one case in which such severe twinges were felt in the

3. *Swelling on a Digital Flexor Tendon*

If the swelling is large, a characteristic symptom is mentioned. The patient complains that he cannot flex his fingers actively on waking in the morning but has to work them up and down with the other hand at first. This loss of active movement coming on after a period of keeping the hand still is accompanied by median numbness. Search for the swelling must not be confined strictly to the territory of the carpal tunnel; *for it may lie several inches up the forearm.* If the swelling lies close to the palm and in connexion with the tendon running to the fourth or fifth fingers, the thenar branch of the median nerve escapes pressure and the pins and needles occupy the index, long and ring fingers only.

Small swellings lead to pins and needles felt to come on after repetitious movements of the hand. At times the patient feels a twinge at the moment when the swelling is felt to dip under the proximal edge of the transverse carpal ligament.

Treatment consists in acupuncture. About half of all cases are relieved, at any rate for some years, by careful location of the swelling and the passage of a needle right through it. This is not so easy to do accurately as one would expect. Presumably, a small fluid core is liberated by the needle. If acupuncture fails, division of the transverse carpal ligament is indicated.

4. *No Palpable Abnormality*

These are very favourable cases to treat and account for about half the total. A needle 2 inches long is introduced at the front of the lower forearm, 1½ inches above the carpus. It is thrust distally until the point lies under the ligament. Ten c.c. of 0·5 per cent procaine are introduced Two or three such injections at fortnightly intervals usually afford lasting relief. Whether the sheath of the nerve is lastingly desensitized or the injection has a purely hydraulic effect is uncertain. If injections fail, the transverse carpal ligament should be divided.

5 *Occupational Causes*

Repeated use of the hand while it is held in extension at the wrist grinds the median nerve against the carpal bones Hence scrubbing on hands-and knees or using clippers is often the ætiological factor After the harmful exertion, the nerve stays tender, being apt to produce paræsthesiæ on very little provocation for some weeks afterwards.

Avoidance of the causative work, aided by local anæsthesia, is indicated Division of the transverse carpal ligament is without avail

6 *Direct Trauma*

A fall on the outstretched hand may bruise the branch of the median nerve running to the thumb at the point where it crosses the medial aspect of the trapezio-first metacarpal joint. For many months afterwards the patient suffers subsequent pain and paræsthesiæ in the thumb alone The symptoms are usually thought to result from a psychogenic disorder

Although it is not easy to find the exact spot with the point of a needle, one injection of 2 c.c. 0 5 per cent procaine solution is lastingly curative. But it may take two or three attempts to infiltrate about the nerve correctly

7 *Stick Palsy*

A patient, perhaps with chronic nervous disease or osteoarthritis in both hips, may habitually squeeze that part of the median nerve running to the index and long fingers by holding his walking-stick the wrong way Instead of gripping the curved handle of his stick across his palm he may grasp it longitudinally in line with his forearm All the pressure is then borne at the exact point of emergence of the median nerve from under the distal edge of the transverse carpal ligament. Persistent paræsthesiæ in the index and long fingers result, which division of the ligament does not alter The same symptoms rarely result from a large swelling on a flexor tendon at the proximal part of the palm.

The patient must hold his sticks the other way and have the handles covered with soft rubber It is often a year before he loses his symptoms

PRESSURE ON THE RADIAL NERVE

This is rare. A minor subluxation of the scaphoid bone may lead to some stiffness of the wrist and paræsthesiæ felt at the dorsum of the three and a half radial fingers owing to pressure on the nerve in the anatomical snuff-box. Examination of the wrist shows the pattern characteristic of internal derangement—limitation of extension only. Manipulative reduction restores movement at the wrist and abolishes the pins and needles simultaneously.

An osteoma projecting dorsally at the base of the third metacarpal bone (sometimes the result of an accessory centre of ossification there) may engage against the branch of the radial nerve running to the index and long fingers. If so, when the hand deviates from side to side during wrist flexion, a sharp twinge is felt when the nerve engages against the projection and crosses over, and these fingers then tingle for several minutes. The exostosis can be removed if the symptoms warrant.

If the sensory branch of the radial nerve catches against the lower edge of the radius, or if it has been bruised at its metacarpal extent, the patient describes a characteristic movement as bringing on the paræsthesiæ. This movement consists in bringing the arm backwards from the dependent position and then twisting it into full medial rotation; with the elbow straight he then flicks the forearm into full pronation and the wrist and fingers into flexion. This position stretches the radial nerve to the maximum and a sharp tingle results.

THE HAND

Pain in the hand usually results from local trauma or over-use. Much weight should be given to the history and the site of pain, which is usually felt exactly at the site of the lesion. Conversely, when pain in the hand is referred from above, the patient knows it. Enquiry is made for changes in colour such as suggest a circulatory disorder, *e.g.* Raynaud's disease or a cervical rib pressing on the subclavian artery.

PARÆSTHESIÆ

Numbness and pins and needles in the fingers are a common symptom which has been named 'acroparæsthesia' They are felt in the hand irrespective of the level at which the causative pressure is exerted Pins and needles in all four limbs characterize disorders such as peripheral neuritis, diabetes, pernicious anæmia, acromegaly, myxœdema and central upper spinal disc lesions

The main diagnostic point is—which fingers?

Thumb alone numbness only—occupational pressure on the digital nerve at the outer side of the thumb

pins and needles—contusion of the thenar branch of the median nerve

Thumb and index fifth cervical disc lesion

Thumb index and long finger fifth cervical disc-lesion or thoracic outlet syndrome

Thumb, index, long and adjacent side of ring finger palmar surface—median nerve in carpal tunnel, dorsum—radial nerve.

Thumb and fifth finger tumour of humerus.

All five digits of one or both hands thoracic outlet syndrome.

All five digits of both hands cervical or upper thoracic central disc protrusion

Index and long fingers palmar surface—trigger finger, indeterminate—sixth cervical disc lesion dorsal surface—carpal exostosis or subluxation.

Index, long and ring fingers sixth cervical disc lesion or carpal tunnel syndrome, 3

All four fingers sixth cervical disc lesion.

Long finger alone ditto

Long and ring fingers ditto

Long ring and little fingers seventh cervical disc-lesion

Ring and fifth fingers seventh cervical disc-lesion or thoracic outlet syndrome.

Ulnar side of ring and whole fifth finger pressure on ulnar nerve at elbow or palm

As always, when a nerve is pressed on, and the paræsthetic area identifies the one affected the whole nerve must be examined from spine to digit the above indications are

probabilities, not certainties. When an area that does not correspond to any one cutaneous nerve is described, the lesion must lie above the differentiation of the relevant plexus.

MUSCLES OF HAND

The muscles most often strained are the interosseous bellies. They may receive a direct injury and are in any case bound to be damaged when a metacarpal shaft is fractured. Musicians, especially violinists and pianists, sprain these muscles by an over-vigorous movement during fingering, and, unless treated, may be permanently unable to play perfectly again.

When, as is the commoner, a dorsal interosseous muscle is strained, the pain in the hand is elicited by a resisted abduction movement of the extended fingers. The tender spot in the muscle must be found—the patient's sensations are a good guide—and deep massage given there. Even after months of disablement that has resisted every conceivable treatment, a musician can be confidently assured that he will find that he can play again tomorrow night. Two sessions of proper massage are curative.

Tendinitis of an interosseous muscle at the base of one of the first phalanges may be difficult to distinguish from a strain of the joint itself. Though the tender spot is level with the joint and that side of the joint is slightly swollen, some of the passive movements at that joint hurt, others do not; then pain elicited by a resisted movement clarifies the diagnosis. Differentiation is important; for two or three sessions of deep massage cure a tendinitis, however long-standing, but have no effect on traumatic arthritis.

Occasionally an abduction sprain of the thumb overstretches a thenar muscle, most often the origin of the oblique abductor muscle at the base of the second or third metacarpal bone.

Considerable ingenuity is required in testing the small muscles of the hand and in finding the tender spot in the structure thus identified. It is well worth while; for all the intrinsic muscles and their short tendons respond immediately to adequate massage.

JOINTS OF THE HAND

Arthritis occurs at any of the joints of the hand and gives rise to limitation of movement. The pattern for the joint is an equal degree of limitation of flexion and extension except in severe arthritis rotation is painful at extremes rather than limited in range The history combined with the appearance of the joint provides the clearest pointer to the type of arthritis present. The relevant points are whether the onset is apparently causeless, traumatic, or the result of immobilization because of neighbouring sepsis whether the affection is multiple or single whether the distal or the proximal joints were affected first whether the capsule of the joint is swollen or not, whether the joint changes colour or not whether there is a familial history of gout or Heberden s nodes.

Traumatic Arthritis

This is common, and results from direct contusion, indirect sprain, chip-fracture or reduced dislocation The history is characteristic the joint itself is swollen in a manner resembling rheumatoid arthritis After severe trauma, the joint is often warm to the touch for a month or so Movement is limited the active, passive and resisted movements must all be tested in case a tendinous lesion coexists

All treatment is futile The joint gets well of itself, treated or not, in the course of six to eighteen months depending on the severity of the original trauma and the age of the patient. Whether the patient uses the joint enough to make it ache or not has no effect on the ultimate result. Immobilization is, of course, strongly contra indicated

Unreduced Dislocation

At the interphalangeal joint of the thumb, dislocation is sometimes mistaken for traumatic arthritis, it is extraordinary how the local swelling obscures the deformity Examination shows the joint to be fixed in full extension, quite different from arthritis in which flexion and extension are equally limited

In late cases, reduction is impossible and arthrodesis in 45° of flexion gives a good result.

Immobilizational Stiffness

Before the days of antibiotics this was the common result of splintage for sepsis. The fingers must not be splinted for a day longer than is absolutely necessary, and never in full extension.

Rheumatoid Arthritis

This never starts at the distal interphalangeal joints, whereas osteo-arthritis usually does. Rheumatoid arthritis often starts as stiffness of the fingers on waking in the morning; at this stage no clinical signs may be perceptible, but the sedimentation rate is markedly raised. Sooner or later one or more metacarpo-phalangeal or proximal interphalangeal joints of one or both hands develop the familiar spindle-shaped swelling. Later on, ulnar deviation of the fingers is characteristic.

An identical picture is presented by multiple subacute arthritis complicating gonorrhœa, chronic gout, psoriasis, and the early stage of scleroderma.

Care should be taken not to assume too readily that the symptoms in a patient with rheumatoid arthritis are due to the rheumatoid disease. A trigger-finger is a common complication, since the tendons are very apt to be affected also. Sometimes the swelling becomes large enough to prevent active, but not passive, flexion of a finger. Since movement is easily restored by a small plastic operation on the tendon-sheath, a correct diagnosis is important. A ganglion lying between the head of the second and third metacarpal bones must not be mistaken for rheumatoid arthritis (see p. 312).

Apart from hydrocortisone, little can be done for rheumatoid arthritis by treatment to the joints; for it is the local manifestation of a systemic disease.

Osteo-arthritis

This may result from a severe injury. In the apparently causeless cases that occur in elderly patients, usually women,

a strong familial trend is evident. The distal joints are affected first after many years the disorder spreads to the proximal interphalangeal joints, very seldom to the meta carpo-phalangeal joints The knobbly appearance of the joint is quite different from rheumatoid arthritis, for the base of the distal phalanx can be seen projecting abruptly as two small rounded bosses at the dorsum of the joint. A varus deformity, usually at the index, may develop at a distal joint Both hands are usually affected more or less symmetrically The radiograph shows the osteophytes and erosion of cartilage clearly From time to time, a new node forms at an affected joint while it is growing there is pain for a month or two and occasionally the finger tip goes pink. This mottled pink is different from the shiny red of gout. After a month or two the discoloration passes off and the node stops hurting

Heberden's nodes and osteo-arthritis cause little in the way of symptoms. They are unsightly and cause aching and clumsiness. No treatment is of appreciable avail A wax bath is comforting Since the distal finger joints fix in 45° flexion in the end, arthrodesis is seldom much improvement unless an intractable traumatic arthritis supervenes after injury

The only diagnostic difficulty is presented by rheumatoid arthritis appearing in a patient who already has osteo-arthritis The sedimentation rate is then a help for it is not raised in osteo-arthritis except very temporarily during an acute episode.

Gout

Involvement of the hands is usually a late manifestation of the disease. The familial predisposition and the history of recurrent attacks, clearing up completely, starting at the big toe and later spreading to other joints, should arouse suspicion The shiny red appearance of the joint is characteristic.

When chronic gout comes on gradually in an old man, the onset and the clinical appearance of the joints may mimic rheumatoid arthritis to perfection. Tophi in the ears and a raised uric acid level in the blood appear in the end, but are of little diagnostic aid in the early doubtful case. There

peutic testing with colchicine ($\frac{1}{50}$th grain four-hourly) and aspirin (10 grains three times a day) for a week gives the clearest answer. Between attacks benemid is an excellent prophylactic agent (0·5 to 1 gm. a day).

TENDONS OF THE HAND

Teno-synovitis

The flexor tendons in the palm may develop much coarse grating in advanced rheumatoid arthritis. Such chronic teno-synovitis causes little or no symptoms and is in any case intractable.

Trigger-finger

A swelling on any of the digital flexor tendons may form just proximal to the metacarpo-phalangeal joint. When big enough, this gives rise to the condition known as trigger-finger or trigger-thumb. When the digit has been fully flexed actively, the swelling engages within its sheath and becomes fixed in this position. The affected finger, usually the third or fourth, can then no longer be extended by muscular action; the patient has to free it by pulling at it with his other hand, whereupon it disengages with a snap. The swelling on the tendon is easy to feel in the palm or thenar eminence, just proximal to the head of the metacarpal bone. Some cases are apparently causeless; others due to multiple minor traumata (*e.g.* using a pair of clippers); yet others complicate rheumatoid arthritis. If necessary a small operation enlarging the relevant part of the tendon-sheath by slitting it up affords permanent cure, but many patients are hardly disabled enough to wish this done. In minor cases it is sometimes possible to secure freedom from symptoms for a time by acupuncture. If the swelling has a fluid centre, this may escape, reducing the size of the projection.

Rarely, the swelling may get so large that flexion of the finger stops at half-range. The fact that passive flexion is not limited draws immediate attention to one of the digital flexor tendons. Equally rarely, the swelling may form on the proximal part of the tendon in the palm and interfere

with the branch of the median nerve running to the index and long fingers

Mallet finger

Any injury that forcibly flexes the distal finger joint while it is actively held in extension may cause rupture of the extensor insertion at the base of the distal phalanx. A cricket ball is often the culprit. The distal joint can be fully flexed voluntarily, the elastic rebound of the tissue takes it back to 45°, the last 45° cannot be actively performed, though the passive movement remains full. The dorsal aspect of the base of the phalanx is tender and swollen

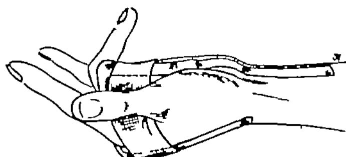


FIG 49—Strapping for mallet finger One piece of strapping extends from the dorsum of the hand, along the finger to the front of the wrist. This fixes the affected finger in flexion at the metacarpo-phalangeal and proximal interphalangeal joints. A second piece of strapping encircles the hand, pressing the finger-tip into the palm. This ensures that the distal interphalangeal joint is kept in full extension.

Treatment should be instituted at once. In young persons the affected finger should be fixed in full flexion on the palm of the hand by one piece of strapping running along from the dorsum of the finger to the front of the wrist covered by another piece of strapping encircling the hand (see Fig 49) This position ensures full relaxation of the distal part of the tendon (since the distal joint is held in full extension) while the tendon is held taut proximally by fully flexing the proximal interphalangeal joint The strapping is kept on for four weeks union between tendon and bone is then firm. In elderly patients keeping the metacarpo-phalangeal joint fully flexed may lead to undesirable stiffness hence it is best to fix the distal joint in full extension and the proximal joint in full flexion by a small plaster gutter letting the metacarpo-phalangeal joint go free. This is kept on for a month, but

union is less sure. Attempts to suture the tendon to the bone operatively are so seldom successful that the late case is best left untreated.

A small tender swelling may form on the flexor tendon level with the proximal crease of a finger. It causes no symptoms unless the patient carries a suitcase; the local pressure then hurts.

Rupture of the flexor digitorum longus at the insertion into the base of the distal phalanx is a rarity. The whole tendon recoils into the palm where it lies bunched up, giving rise to a swelling superficially resembling Dupuytren's contracture. The distal finger-joint cannot be actively flexed, though the passive movement is retained. Arthrodesis is called for if the patient's work is interfered with.

Ganglion

A ganglion sometimes forms between the heads of the second and third metacarpal bones, and is nearly always mistaken for rheumatoid arthritis. It gives rise to vague local aching. Inspection of the hand shows the swelling to project between the bones; movement at the two adjacent metacarpo-phalangeal joints is of full range and painless; the radial side of the second and the ulnar side of the third metacarpo-phalangeal joint are clearly not swollen, and palpation reveals a fluctuant swelling. Acupuncture affords permanent relief: I have yet to meet a recurrence.

A ganglion may form on the front of the palm just distal to the hamate bone. It lies hidden under the hypothenar muscle bellies and causes no symptoms until it gets large enough to compress the ulnar nerve. Ulnar paraesthesia and weakness result, for which no cause can be found as the nerve is followed down until this swelling is detected in the proximal part of the palm. Up to 5 c.c. of mucus may be obtained on aspiration. If the ganglion fills up again quickly, as it is apt to do, it should be removed before the palsy becomes too severe. I have not yet [illegible]pted sclerosing injections in such a ca[illegible] only one instance of a swelling [illegible] running to the fifth finger, pron[illegible] nar nerve. The condition was [illegible] above the wrist [illegible]

An ulnar palsy of similar nature comes on in workmen who repeatedly hit a lever with the front rather than the side of the ulnar border of the hand

Multiple Xanthomata

These occur in the extensor tendons of the fingers, at the dorsum of both hands and along the proximal phalanx. The tendons present a number of closely spaced discrete nodules causing visible projections that can be seen to move up and down with the tendons No symptoms result and no tendency to rupture has been noted. Bilateral involvement of the tendo Achillis is almost a certainty Finally, large nodes form on the extensor tendons at the dorsum of the foot and on the front of the upper tibiæ and the back of the upper ulnæ The blood cholesterol level is usually greatly raised, to twice or three times the normal level (200 mg) If the projections on the long bones annoy, they can be removed Apart from that, no treatment is possible or required however since the patient usually fears that he has rheumatoid arthritis, strong reassurance is called for

BONES OF THE HAND

Clubbing of the distal phalanges occurs in pulmonary disease and psoriasis The whole skeleton of the hand enlarges greatly in acromegaly In sclerodactyly the bones of the fingers are narrow and tapering with the skin stretched tightly over them the joints are contrastingly prominent

Fractures are common.

Post traumatic Osteoporosis

This is a curious and rare sequel to injury, first described by Sudeck in 1900 It nearly always follows a fracture of the forearm near the wrist (*e.g* Colles s) or of the leg near the ankle. Cases have been described, however after an otherwise unexceptional sprained ankle, not even treated by splintage

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An ulnar palsy of similar nature comes on in workmen who repeatedly hit a lever with the front rather than the side of the ulnar border of the hand

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A week or two after the accident the wrist and fingers swell and considerable pain is experienced on movement

The distal part of the limb goes cyanotic and cold; the lower leg becomes almost black when left dependent for a few minutes. The range of movement at carpus (or tarsus) and fingers (or toes) diminishes rapidly. Trophic change supervenes and the nails stop growing. The radiograph, which showed no such change just after the injury, reveals severe osteoporosis involving the distal part of the broken bone and the entire hand or foot, far more than can be accounted for by immobilization. Union of the fracture proceeds normally.

The cause is unknown. No treatment to the hand makes any difference; recovery (which may never be complete, some stiffness remaining permanently) takes one to two years. *A stellate block (see p. 646) should be induced as soon as the patient is seen*; if benefit follows, it should be repeated as often as is necessary. In any case active use of the injured hand or foot should be enjoined. The radiograph shows a degree of atrophy so extreme as to suggest that the bones of the foot might easily give way under the stress of weight-bearing; moreover, softening, such that the affected bones can easily be cut with a knife post-mortem, has been described. Nevertheless, no harm results from ordinary weight-bearing activities and no case of subsequent deformity has come my way Attempted treatment by heat is contra-indicated for an increased circulation enhances rarefaction of bone.

PALMAR FASCIA

A painless contracture of the palmar fascia, named after Dupuytren (1882) but first described by Sir Astley Cooper in 1822, may develop slowly, usually towards middle age, and lead to fixed flexion deformity of the fingers. It affects the ring finger most often, but sooner or later the third and fifth fingers also become involved It is usually bilateral, but considerably more advanced on one side than the other. The palmar fascia thickens, becomes adherent to the skin and the cause of the deformity is obvious. The disorder is familial; four-fifths of the patients are men.

In the early stage, the patient should himself be taught to stretch out his finger daily so as to elongate the palmar fascia as fast as it contracts. Later, a plastic operation using a

Z shaped incision followed by splintage in extension of the fingers and daily movements both by the physiotherapist and by the patient, become necessary He should be warned that, even after successful excision of the fascia, recurrence is very probable unless he keeps on forcing extension for the rest of his life A splint should be worn at night permanently

Ultra sonic waves break up the fibrous tissue mechanically and after many months' treatment some improvement is secured. Vitamin E in huge doses has been claimed as curative (Thomson 1949), but these results have not been confirmed Radiotherapy has been commended

DIGITAL NERVES

Occupational pressure on the radial side of the thumb leads to numbness rather than pins and needles felt at the outer border of the distal phalanx. The workman is found to steady his hand against the edge of his bench Recovery usually takes six months. Rarely the ulnar side of the little finger suffers in the same way

Swelling on a digital flexor tendon in the palm may squeeze a digital nerve and set up paræsthesiæ felt at the contiguous sides of two fingers (see p 310)

Direct trauma may bruise the thenar branch of the median nerve where it crosses the trapezio-first metacarpal joint (see p 308)

A ganglion adjacent to the hammate-fifth metacarpal joint may lead to an ulnar palsy (see p 312)

Many diseases begin by setting up symptoms referable to the hand *e.g* cervical rib progressive muscular atrophy, paralysis agitans, syringomyelia, chorea and thyrotoxicosis.

WRITER'S CRAMP

This is an occupational neurosis, the patient finding himself able to do everything effortlessly with his hand, except write. It is thus evident that the mental concept of writing interferes with the act of writing There are two types of complaint (1) pain and (2) involuntary movements.

1 *Pain.* If the pain comes on as soon as the pen is

grasped, the source of the symptoms must lie in the cerebrum. In such cases, physiotherapy and psychotherapy have each proved valueless.

If the pain comes on after a time, it may be caused by ischæmia. Arrest of circulation in the forearm is possible if such great and continued force is used in grasping the pen that the muscles are kept in tetanic contraction. In such cases the physiotherapist can help the patient by re-educating muscular relaxation. She holds his upper forearm while he sits writing, and stops him each time she feels the contraction become excessive.

The carpo-pedal spasm of tetany (often set up by hyperventilation) must be distinguished from painful writer's cramp.

2. *Involuntary Movements.* After some words have been laboriously written, the patient finds his hand straying away, lifting the pen from the paper. Alternatively sharp jerks may occur. These cases must be differentiated from the slow writing characteristic of early Parkinsonism. No treatment avails; the patient must learn to use a typewriter.

CIRCULATORY DISORDERS

These do not give rise to true pins and needles, but rather to tingling felt when the hand changes colour. Pain and a dusky red colour occur in erythromelalgia. In Raynaud's phenomenon, one or more fingers blanch for hours on end owing to spasm of the digital arteries If a stellate block abolishes the cyanosis for the time being, this ganglion should be removed surgically.

Chilblains are commonplace when damp and cold are combined; mere dry cold is not enough. A hundred thousand units of vitamin D should be taken daily during two courses of a month each in November and January. During the coldest weather, 50 mg. of nicotinic acid should be taken three times a day after meals. Toxic effects are not to be expected from this dosage of vitamin D; they are thirst, polyuria, constipation, nausea, headache and lassitude. The blood urea level rises, not the blood calcium level.

A cervical rib may irritate the subclavian artery and lead

to ischæmia of the hand and temporary abolition of the radial pulse.

Traumatic spasm of the brachial artery is usually the result of fracture near the elbow If it does not subside quickly when the patient's body (but not his injured arm) is well warmed it should be dealt with at once by operative exposure. The spastic length of artery is bathed in papaverine solution (Kinmonth, 1952) and lasting relaxation ensues

ŒDEMA OF THE HAND AND FOREARM

Angioneurotic Œdema

When œdema of the dorsum of the hand occurs without apparent cause, it is termed "angioneurotic." It may be an allergic manifestation, but in some cases the chief underlying factors are psychological. The œdema is usually most marked on waking disappearing as the day goes on. Pitting is easily produced, deep effleurage always abolishes the swelling temporarily No treatment appears to make any lasting difference, unless an allergic sensitivity is found and contact with the substance responsible avoided or desensitization carried out. The antihistamine preparations may be tried.

Interference with Lymph or Venous Return

Thrombosis of the axillary vein or interference with the drainage of lymph as the result of operative removal or carcinomatosis of the axillary glands should be considered

Post traumatic Œdema

The cause of this uncommon sequel to injury to the hand is obscure The distinguishing feature is that the œdema stops abruptly at the wrist or elbow instead of gradually fading away The ridge formed by the upper extremity of the œdema is clearly palpable The patient may allege much pain and disablement, and may add that the grip is weak and the hand numb The œdema is clearly real but there is a full range of movement at every joint, and no weakness or

wasting of the muscles is discernible. Radiography reveals at the most some disuse atrophy. The supposition that the condition is an hysterical manifestation has received support from the work of Scott and Mallinson (1944), who cured a number of patients by psychotherapy, some in a few weeks. Patients with a similar degree of œdema due to operative removal of the axillary glands report at the most a sensation of disagreeable tension; they are in no way disabled by the swelling.

In some (possibly all) cases the œdema is an artefact, produced by the application of a tight band.

CHAPTER XIV

THE THORAX AND ABDOMEN

SYMPTOMS referable to the thorax arise from a wide variety of disorders, somatic as well as visceral. Moreover thoracic disease may give rise to pain felt wholly outside the thorax, in the abdomen perhaps, or the upper limb Since the somatic structures move, their clinical examination is not complicated hence the usual attitude towards pain in the chest unaccompanied by fever might be reversed with advantage, the muscles, joints, bones and dura mater being examined first and the more involved methods required for examining the viscera employed if a blank is drawn.

The common sources of thoracic pain are

1 *The Neck*

Displacement of part of the third and fourth cervical intervertebral discs sets up pain felt to radiate as far as the root of the neck, at the fifth and sixth levels pain felt as far as the mid or inter scapular area is a commonplace, at the seventh level the pain is often wholly mid thoracic, sometimes at its most intense at the lower angle of one scapula. Great opportunities for a mistaken diagnosis thus exist for no anatomical explanation of this phenomenon can be put forward and many physicians therefore doubt its possibility on, after all, very good grounds

Even more misleading reference occurs at times Instead of a cervical disc lesion setting up scapular pain—the familiar symptoms for so long called fibrositis of the trapezius"—it gives rise to pectoral pain only This is no greater a trans gression of the rules of segmental reference than the pain being felt in the same dermatome posteriorly Being a rare form of reference, however, the true diagnosis may not even be considered

2. *The Thoracic Joints and Dura Mater*

Internal derangement here can give rise to pain felt only anteriorly in the thorax or abdomen; if posterior, it may be unilateral or central. In all of these, a deep breath often hurts. A thoracic protrusion may also set up sternal pain: a most misleading symptom.

Various compression phenomena occur at the intervertebral joints, causing central posterior or bilateral pain, sometimes referred round to the sides of the lower thorax.

Ligamentous pain occurs in spondylitis deformans.

3. *The Ribs*

Fracture is common and results in localized pain. Disease is uncommon and is usually due to bacteria or new growth.

4 *The Muscles*

The intercostal muscles are, of course, slightly torn when a rib breaks; they may also be bruised or, in athletes, only strained. Direct bruising of the digitations of the serratus anterior occurs In either case, the pain is very localized.

A more diffuse thoracic pain, often referred to the arm as far as the elbow, results from strains involving the pectoralis major or latissimus dorsi muscles.

5. *The Bones*

Wedge fracture of a vertebral body, if uncomplicated, causes symptoms for not longer than three months. For the first week there is often a girdle pain. Kyphotic compression of the anterior aspects of the vertebral bodies gives rise to a postero-central bone-to-bone ache that can go on unchanged for decades. Senile osteoporosis causes no symptoms unless, as may happen, pathological wedge-fracture occurs. An angular kyphos is often very difficult to palpate at the thoracic spine.

Osteitis deformans, aortic aneurysm, tuberculous caries and secondary malignant deposits in the spine or sternum naturally set up pain arising from diseased bone.

Except in the young, sternal pain naturally suggests angina pectoris It is therefore important to remember that this may be the only symptom of a thoracic disc-lesion protruding centrally or of the painful contracture of the anterior longitudinal ligament that occurs in spondylitis deformans More often, in both these disorders, the pain is posterior as well I have met with only one instance of pain arising in the manubrio-sternal joint It had been brought on by severe dyspnoea after unaccustomed exertion in a middle-aged man and had lasted two years

6 *The Nerve Trunks*

Infectious neuritis of one of the various nerves of the pectoral girdle gives rise to a constant unilateral pain usually lasting some weeks, especially if the suprascapular or the long thoracic nerve is affected

When infectious neuritis attacks the fifth and sixth cervical roots the patient may have diffuse unilateral thoracic pain for the first few days

7 *The Diaphragm, Pleura and Lung*

Diaphragmatic pain is often felt at each breath in the shoulder and arm only, but may have a thoracic component as well. Pain arising from that part of the pleura not in contact with the diaphragm accompanies respiration and is usually felt in the chest. The lung is insensitive, but large tumours invade the chest wall, setting up local pain and causing spasm of the pectoral muscles, with consequent limitation of movement at the shoulder (of the non-capsular pattern)

8 *The Myocardium*

The heart is developed from the first, second and third thoracic segments. Hence pain originating here may be felt spreading from the thorax to the root of the neck and to the upper limb as far as the ulnar border of the hand on the left or on both sides Alternatively, there may be thoracic pain only or less often, pain confined to one or both upper limbs.

9. *The Abdominal Viscera*

Disease of the liver or pancreas, or adherence of a gastric ulcer to the upper lumbar spine, may give rise to pure posterior mid-thoracic pain. A leaking aorta with hæmatoma formation after an intra-arterial pyelogram may cause puzzling lower thoracic pain.

THORACIC DISC-LESIONS

Since the cervical and lumbar symptoms once ascribed to "fibrositis" are now becoming more generally regarded as having an articular origin, the question naturally arises: are the thoracic symptoms once ascribed to fibrositis also caused by disc-lesions? I have slowly come to the conclusion that they are (Cyriax, 1950). The marked signs that eventually serve to clarify the diagnosis in cervico-lumbar protrusions seldom appear at the thorax, however long a patient is kept under observation; hence this theory is correspondingly difficult to prove. Moreover, operation, which has established the pathology of disc-lesions in the lumbar and cervical regions so firmly, is very seldom possible or necessary at the thoracic spinal joints.

At the cervical and lumbar joints an alternation exists that leads to simplicity in diagnosis. A minor degree of protrusion interferes with the joint, not yet with the nerve-root; hence local pain and articular signs are at their most obvious when neurological signs are lacking. In contrast, when the protrusion has passed postero-laterally and interferes little with joint movement, it exerts its maximum pressure on the nerve-root; hence root pain and clear neurological signs supervene as the articular symptoms and signs fade.

Disc-lesions occurring at the thoracic joints by no means show this characteristic sequence. There is an extraordinary variation in the mode of onset; moreover the articular signs are seldom obvious, and neurological signs are conspicuous only by their absence. No wonder, therefore, that clinicians properly hesitate to inculpate a thoracic joint as the source of what used at the trunk to be called "fibrositis," "pleurodynia," or "intercostal neuritis."

Diagnosis is, therefore, always difficult, confusion with visceral disease being excusably very frequent. Indeed it is always safest to approach diagnosis from both sides, the absence of signs of visceral disease balancing and confirming those of an articular nerve-root disorder A recent paper (Allison, 1950) draws attention to the fact that pain arising in association with spinal curvature and osteo-arthritis or from disorders of the chest wall simulates heart disease. Several case-histories are quoted characteristic of thoracic disc-lesions

From the clinical point of view, *the thoracic spine starts at the third vertebra*, the upper two thoracic joints and nerve-roots being best examined as part of the neck. Moreover the upper two thoracic segments form part of the inner aspect of the upper limb, thus being most easily examined with the cervical segments that make up the larger part of the limb

SYMPTOMS

These form six groups

1 *Articular Type*

(*a*) *Posterior* The patient describes how some movement caused him sudden severe pain at one or both sides of the lower thorax posteriorly He is immobilized in flexion, the pain being aggravated by attempting to stand erect, breathing or coughing As a rule, a deep breath hurts more than a cough—a distinguishing point between thoracic disc lesions and *pleurisy or lumbar lumbago* when a cough is *far* more painful than a deep breath He may have to spend a few days in bed Recovery is usually swift. The spinal flexion movement that occurs at the onset of an electrically induced convulsion quite often gives rise to a thoracic disc-lesion, possibly with a minor wedge-fracture as well.

After this attack, he is subject to recurrences, usually brought on by bending or twisting his trunk, especially during weight bearing The pain may be on one side during one attack, on the other side during another, movement

of the loose fragment across the mid-line appears to be a commonplace The pain at one side of the back of the chest often radiates to the lower costal margin anteriorly; the patient describes it as a burning ache. If the anterior pain becomes severe, the posterior component often disappears (as in cervical or lumbar disc-lesions). During an attempt at manipulative reduction, the pain is often shifted from one part of the chest wall to another (as happens also when cervical disc-lesions are being reduced); the pain may even move from one side of the body to the other

Professional golfers are apt to develop this type of lower thoracic disc-lesion as an occupational disorder; for a strong and accurate swing entails full rotation of the thorax on the lumbar spine (at these joints no appreciable amount of rotation occurs). They thus fragment the cartilage by prolonged wear and tear.

(*b*) *Anterior*. 1. *Sudden Onset*. Less often the pain is sternal or epigastric. The patient, during some exertion, develops pain at the front of the chest, sometimes severe enough to resemble angina or an abdominal emergency. However, a deep breath and moving the thoracic joints both hurt. This distribution of pain occurs chiefly in elderly patients who already have considerable osteo-arthritis at their thoracic spinal joints. Rest in bed may not bring about cure, since the presence of so much capsular contracture and osteophyte formation hinder the very movements that would bring about eventual reduction.

When the pain becomes anterior, whether centrally or above or near the costal margin as in the previous variety, the patient breathes shallowly, loses his appetite and may even vomit during an acute attack—three most misleading symptoms.

Four years before he was seen by me, a man aged 53 had had a coronary thrombosis necessitating four months in hospital During his time in bed, he developed another pain at the right side of the sternum, spreading at times to the whole right side of the chest in front and behind. In greater [illegible] me [illegible] ad this pain for some hours ev[illegible]
A mo[illegible] n attack of severe

sternal pain causing him to be urgently admitted to hospital under his cardiologist In due course, the lack of constitutional and cardiac signs showed that his symptoms were not anginal and he was discharged four days later, after his pain had considerably eased. At his first visit to me the pain in his chest of four years' standing was present.

Study of the neck, scapular and thoracic movements strongly suggested the presence of a thoracic disc-lesion at the third or fourth level

Manipulative reduction was carried out on three occasions in the course of a week, until all his pain was abolished Six months later he was still entirely pain free.

2 *Slow Onset.* Central sternal pain, sometimes associated with central interscapular pain as well, may come on slowly, often in the course of some months or years, most often between the ages of fifteen and twenty five. The patient often volunteers that neck flexion and a deep breath bring on the sternal pain

In elderly patients, if movements of the neck and thorax do not influence the sternal pain, the bone should be palpated and examined radiographically for, if visceral pain is excluded and thoracic spondylitis deformans is absent, secondary deposits in the sternum should be suspected

2 *Nerve-root Type*

The patient finds that, after sitting or bending forward for a while, *he is liable to unilateral anterior thoracic aching* which passes off after he has remained erect for some time or after a night's rest. Though confined to the antero-lateral aspect of the lower chest wall, the pain moves about to different places within this limit. Some point within the painful area is sure to have been found tender by the patient, which may cause difficulties in distinguishing between a thoracic disc-lesion and post traumatic scarring of an inter costal muscle

If one of the lowest thoracic nerve-roots is compressed, pain in the iliac fossa sometimes radiating to the testicle results Occasionally there is no abdominal aching merely

of the loose fragment across the mid-line appears to be a commonplace The pain at one side of the back of the chest often radiates to the lower costal margin anteriorly; the patient describes it as a burning ache. If the anterior pain becomes severe, the posterior component often disappears (as in cervical or lumbar disc-lesions) During an attempt at manipulative reduction, the pain is often shifted from one part of the chest wall to another (as happens also when cervical disc-lesions are being reduced); the pain may even move from one side of the body to the other

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(*b*) *Anterior* 1 *Sudden Onset.* Less often the pain is sternal or epigastric. The patient, during some exertion, develops pain at the front of the chest, sometimes severe enough to resemble angina or an abdominal emergency. However, a deep breath and moving the thoracic joints both hurt. This distribution of pain occurs chiefly in elderly patients who already have considerable osteo-arthritis at their thoracic spinal joints. Rest in bed may not bring about cure, since the presence of so much capsular contracture and osteophyte formation hinder the very movements that would bring about eventual reduction

When the pain becomes anterior, whether centrally or above or near the costal margin as in the previous variety, the patient breathes shallowly, loses his appetite and may even vomit during an acute attack—three most misleading symptoms.

Four years before he was seen by me, a man aged 58 had had a coronary thrombosis necessitating four months in hospital. During his time in bed, he developed another pain at the right side of the sternum, spreading at times to the whole right side of the chest in front and behind In greater or less degree he had had this pain for some hours every day ever since.

A month previously he had had an attack of severe

sternal pain causing him to be urgently admitted to hospital under his cardiologist In due course, the lack of constitutional and cardiac signs showed that his symptoms were not anginal and he was discharged four days later, after his pain had considerably eased. At his first visit to me the pain in his chest of four years' standing was present.

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If one of the lowest thoracic nerve-roots is compressed pain in the iliac fossa sometimes radiating to the testicle results Occasionally there is no abdominal aching merely

pins and needles felt in the testicle or groin. Rarely, the sole symptom is a unilateral band of unpleasant tingling felt as the patient passes his hand down the front of the chest wall.

3. *Dural Type*

The patient states that he feels nothing unless he bends his head forwards. He then notices a sharp stab at one side of the mid-sternum as full flexion is attained, disappearing as soon as this position is released. Rarely, instead of feeling pain, he complains of pins and needles coming on just below the nipple, felt only when the neck is fully flexed.

4 *Self-reducing Type*

The patient wakes comfortable, but as the day goes on an increasing ache comes on centrally at the mid-thorax posteriorly. As the pain gets worse it spreads radially until the whole of the back of the chest aches Compression of any sort, *e.g.* carrying, soon becomes unbearable, lying brings relief, quickly at first, but only after an hour or two in later years. A deep breath hurts as a rule at the height of the pain The patient sometimes notices that putting his elbows on a table and supporting his head on his hands brings ease.

There is also a less obvious variant of this account. An elderly patient states that, if he sits or bends down, pain comes on after some minutes, in the region of the epigastrium or the umbilicus. This gets gradually worse, finally forcing him to get up or to go and lie down. In either event, the pain disappears within a few minutes, only to return when he sits or stoops once more. The pain may radiate a little to both sides of the abdomen; nothing whatever is felt posteriorly at the affected joint. This appears to me a dural type of reference but, in my experience, neither a cough nor a deep breath hurts the seated patient, hence this idea lacks confirmation.

5 Spinal Cord Type

Pins and needles come on in both feet, gradually spreading to include the legs and thighs Then weakness and some numbness of the legs set in There is no backache to speak of, but vague girdle pains are usually mentioned Pressure from a central protrusion on the thoracic cord clearly accounts for some cases of what used to be called transverse myelitis

6 Brachial Type

(I am indebted to Dr M. Woodhouse for recognition of this type, when Chief Assistant in the department, he pointed out the existence of this variety to me.) The patient complains chiefly of pins and needles in both hands, he may have vague pain along the inner aspect of the arms and often some bilateral scapular aching as well. In theory, no thoracic disc-lesion could set up pins and needles in any but the little finger in fact, this is not so and all the fingers may be affected

SIGNS

The proper examination of any part of the spinal column involves

1 Inspection of the whole trunk
2 Noting the range and painfulness or not of each active movement at the requisite levels
3 Testing the muscles about the joint while this is held still i.e the resisted movements
4 Testing the joint while the muscles stay relaxed i.e the passive movements
5 Testing for dural pain
6 Testing the dural investment of the nerve root at the intervertebral foramen (upper two thoracic and lower three lumbar levels only)
7 Testing conduction along the relevant nerve-roots
8 Testing conduction along the spinal cord (cervico-thoracic spine only)
9 Palpation for deformity
10 Radiology

11. Lumbar puncture.
12. Occasionally, contrast myelography

Though this may seem a formidable list of diagnostic procedures, clinical examination does not in fact take long. As regards the thorax, all that need be done in order to deal with each of these points in turn is·

Inspection

The patient stands with light falling evenly on his back, its general shape being noted The angular kyphos characteristic of a collapse of a vertebral body is quickly seen and can later be palpated; a flat lumbar spine and excessive upper lumbar kyphosis suggest spondylitis deformans or a past adolescent osteochondritis Scoliosis and kypho-lordosis are immediately visible, of course, but neither has any significance; for disc-lesions do not appear more common in patients with these postural deformities than in others.

Active Movements

The patient is asked to perform flexion, extension, side-flexion and rotation of the trunk in each direction. Whether the range is full or limited—if limited, in which directions—and whether pain is or is not elicited at one or more extremes of range is noted. Special care is taken to enquire for pain occurring momentarily at mid-range; for a painful arc often occurs on trunk-flexion, side-flexion and/or rotation, and is pathognomonic of an intra-articular displacement (Cyriax, 1947).

If the patient's symptoms are felt in the upper half of the posterior thorax, it must be remembered that their probable source is a cervical disc-lesion or, *e.g*, long thoracic or suprascapular neuritis Though it is uncommon, a lower cervical disc-lesion may give rise to pectoral pain; this is no greater a theoretical transgression of the law of segmental reference than its provoking scapular pain. In such a case, too, it is the neck movements that set up the anterior thoracic symptoms and, if neurological signs are present, they are to be found in the—painless!—upper limb. Hence, it is only if examination of the neck, scapula and upper limb reveals

no abnormality that the existence of a thoracic lesion is suggested.

Passive Movements

Passive extension during prone-lying and passive rotation while the patient sits suffice to afford clear information on the state of the thoracic joints at which, in the young 90° range in each direction is present.

Resisted Movements

At the thorax, the resisted movements have particular importance. Unlike the cervical and lumbar regions where, in my experience, muscle lesions do not occur, the muscles of the thorax may become painful as the result of post traumatic scarring This event often follows direct bruising of an intercostal or the serratus anterior muscle, or strain leading to rupture of a few fibres of the pectoralis major or latissimus dorsi muscle Hence, not only must thoracic ex tension (prone) flexion (supine), side-flexion (side lying) and rotation (sitting) be tested against resistance, but the resisted scapular and arm movements must be carried out as well.

Result

The articular pattern that emerges when a thoracic spinal lesion is present is as follows pain, perhaps also limitation, on some thoracic active movements, more pain when these movements are carried out passively, no pain when the same movements are attempted against so great a resistance that the joint stays still A combination of articular with dural signs is common, but either may, of course, exist alone In most patients with a mid thoracic disc-lesion approxima tion of the scapulæ brings on the pain because of pull on the dura mater via the upper two thoracic nerve-roots

By now the examiner possesses invaluable information on the state of the joints and the muscles at the front and back of the thorax There is no way of obtaining these diagnostic criteria other than by this type of clinical examina tion hence it must be thorough Not only can the examiner tell whether an articular or muscle lesion is present, and

which of the two it is; he can also tell when he is dealing with pain referred to the chest wall, since in such cases none of the movements tested hurts or is relevantly limited. He can also quickly detect psychogenic symptoms, for such patients are hopelessly muddled by this sort of examination and, instead of producing a tidy pattern identifying this joint or that muscle as the culprit, are compelled to answer at random. Thus a self-contradictory series of answers emerges, inconsistent with any one lesion.

Dural Pain

This is elicited by asking the patient to bend his neck forwards as far as possible while keeping his trunk erect. Rarely neck-flexion is actually limited; more often the thoracic pain is set up, either anteriorly or posteriorly, at the extreme of range. Neck-flexion during trunk-flexion or during straight-leg raising may bring on the symptoms when neck-flexion in the erect position does not. Thoracic pain felt on neck-flexion has naturally been attributed to tension on a "fibrositic" sacrospinalis muscle. The fact that this muscle is not at fault can be simply demonstrated by testing resisted neck-extension, which will be found not to hurt. This means that neck-flexion is hurting a structure running the whole length of the trunk, but not the sacrospinalis muscle; only one possibility remains—the dura mater. Stretching the dura mater is painless unless the membrane is thus made to catch against an intraspinal projection, *i.e.* a fragment of disc or, less often, a small benign tumour.

Symptoms of pleural, intercostal muscular, costal and dural provenance are all increased on coughing or deep inspiration; hence respiratory exacerbation serves to rule out cardiac pain only. Pressure on the dura mater at any thoracic level does not, as at the lower lumbar levels, give rise to limitation of straight-leg raising, but the pain caused by a lower thoracic protrusion may be increased, or the pain on neck-flexion aggravated, during full straight-leg raising.

Parenchymatous Involvement

Conduction along an intercostal nerve is seldom appreciably affected in thoracic root-pressure caused by a protruded

disc hence articular signs with root pain without signs of impaired conduction form the usual combination A small area of cutaneous hypersensitiveness or analgesia is occasionally demonstrable anteriorly alternatively a wide band is found with borders so ill-defined as to afford no real help towards indicating the level of the protrusion. Occasionally a small patch of analgesia in the groin characterizes pressure at the twelfth thoracic level. Paralysis of one intercostal muscle would, on the contrary, be highly significant, but I have yet to detect this phenomenon Electromyography might help here.

Disc-protrusion at the first thoracic level should provide a welcome exception, since clear signs of a first thoracic root palsy would obtrude as soon as the strength of the patient's hand was tested However, I have not yet encountered a case of unilateral first thoracic root pressure severe enough to weaken the small muscles of the hand (see p 157) Cases with such signs have turned out to suffer from other conditions *e.g* secondary malignant deposits in a vertebra, pulmonary sulcus tumour pressure by a cervical or first rib, or pressure on the ulnar nerve at the elbow or wrist

Spinal Cord Signs

Pressure on the spinal cord is rare, but in all cases of suspected thoracic disc-protrusion the signs of an upper motor neurone lesion should be sought, whether articular and nerve-root signs are present or not. If the posterior displacement lies strictly centrally, articular and nerve root signs are absent, but in large postero-lateral protrusions, the signs of both disorders may be combined

Pins and needles felt in both lower limbs on neck flexion may prove the only symptom or sign, occurring equally with a central cervical as with a central thoracic (but not lumbar) protrusion. In a recent case, much anxiety is naturally aroused. But I have seen cases of minor spastic uni or di plegia caused by a thoracic disc-lesion whose symptoms and signs have remained unaltered for up to twenty years Even osteopathy has in some cases proved harmless though it has also in my experience precipitated catastrophic re-

Manipulative reduction should be carried out: (*a*) without general anæsthesia; (*b*) during traction. The actual manipulations are described in Vol. II, and only general principles require mention here.

Traction is applied either by two assistants—one pulling on the patient's arms or head, depending on the level of the lesion, the other at his feet—or on a mechanical traction-couch. If two physiotherapists trained in this work are employed, they can help the manipulator a great deal by altering their line of pull at the same moment as he forces the requisite movement

After each manipulation, the patient stands up and states what difference (if any) he notices; the manipulator notes any objective alteration in the range of movement at the affected joint This precaution prevents patients being made worse, as is sometimes unavoidable during general anæsthesia. As long as any particular manipulation does good, it is repeated. When it ceases to help, the manipulator passes on to the next one. This goes on until full reduction has been secured, or the patient has clearly had enough for one day, or it becomes evident that an irreducible protrusion is present

Once well, the patient must attend again *at once* if he suffers a recurrence, indeed, it is an exceptional patient with a thoracic disc-lesion who attends less often than once every year or two

It follows, therefore, that even when a correct diagnosis has been made and the services of a skilled manipulator are constantly available, permanent relief is by no means always assured However, it is usually possible to keep a patient lastingly comfortable, by dint of reducing his protrusion by manipulation at once as often as it recurs.

Prevention of Recurrence

Whereas a corset is a great protection against recurrence in lumbar disc-lesions, no corresponding benefit accrues from wearing a corset extending as high as the upper thoracic levels. No patient can bear pressure on the front of the chest sufficient to make the posterior part of the corset really support the back of the upper trunk. A brace with axillary

steels is effective, but it is often regarded by the patient as worse than the disorder it sets out to prevent. A useful compromise in lower thoracic disc-lesions is provided by a moulded plastic jacket with a small projection against the lower sternum (see Fig 50) It is light and comfortable,

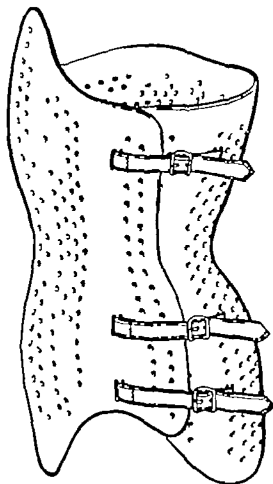


FIG 50—Moulded perforated plastic jacket. For the maintenance of reduction in lower thoracic disc-lesions or exceptionally unstable lumbar disc-lesions. A perfect fit is secured and the sternal projection effectively prevents trunk flexion (Campbell, Theraplastics)

stiff rather than tight, easy to clean and perforated for ventilation

Since the thoracic spine is devoid of lordosis, the patient, though he must do his best, cannot always keep his intervertebral joint so tilted that it is wider open in front than behind, as he can in the avoidance of recurrence at the lower lumbar levels This is particularly so after a wedge-fracture

natural dislike for even the minor discomfort entailed by reduction of a thoracic disc-protrusion. In spite of careful explanation, they beg for anæsthesia, which should as far as possible be avoided, since its employment makes unnecessary difficulties for the manipulator and enables a patient, possibly justifiably, to say that the treatment has made him worse. Unless the doctor in charge of the mental aspect of the case is quite certain that the patient is not in a frame of mind to allege aggravation, anæsthesia is strongly contra-indicated. Even then, it is far safer to spread what would ordinarily be a session of fifteen minutes' manipulation over several visits than to embark on anæsthesia.

OSTEOPATHY

The difficulty in distinguishing between visceral disease and root-pressure set up by a thoracic disc-lesion is responsible for many errors in diagnosis. Not only that, but doctors' mistakes have served to strengthen osteopaths' claims that visceral disease results from vertebral displacements. The osteopath himself is misled when the patient, after his spine has been manipulated, declares that his, say, " cholecystitis " or " angina " has ceased. Hearing that a doctor has declared visceral disease to be present, and finding that his spinal treatment has relieved it, the lay manipulator naturally imagines that he has really cured a visceral disorder. The many vocal and satisfied clients of osteopaths, most of them by no means the neurotics so many doctors suppose, combine to show how often the presence of a thoracic disc-lesion remains unsuspected. Doctors render a disservice to their own profession and present a gratuitous advertisement to lay manipulators every time that a patient with a cervical, thoracic or lumbar disc-lesion capable of manipulative reduction is left to wander on his own initiative into unqualified men's hands, instead of being directed to a hospital where such treatment forms an integral part of the everyday work of the physical medicine department.

COMPRESSION PHENOMENA

Since some degree of kyphosis is universal at the mid and upper thoracic joints, symptoms due to gradual retropulsion are common, especially in individuals with a marked thoracic kyphosis.

1 POSTERIOR BULGING AT THE THORACIC SPINAL JOINTS

This condition is probably caused not so much by an actual disc-lesion as by a gradual and slight movement backwards of the entire intra articular contents at several adjacent joints After some years, this pressure stretches the posterior longitudinal ligament, bulging it backwards against the dura mater The greater the patient's thoracic kyphosis, and the more he compresses the spinal joints, the greater the likelihood of this phenomenon occurring

Diagnosis This is made largely on the symptoms, which are characteristic. The patient wakes comfortable, as the day goes on the posterior thorax begins to ache centrally The ache gets slowly worse spreading bilaterally until the whole of the back of the chest is painful. Carrying anything heavy or sitting upright for some time (*e.g* at the typewriter) increases the symptoms lying down for a few minutes, later some hours, brings relief While the pain is bad, a deep breath usually hurts This pain goes on alternating coming on earlier in the day as the years go by, and taking longer to abate with recumbency Improvement follows change in the patient's circumstances, *e g* leaving a kyphotic occupation (such as sewing) or acquiring domestic help

Examination shows minimal articular signs and an absence of all other signs The examination includes the active, resisted and passive movements of the neck, thorax, scapula and arm, together with ascertaining the absence of any relevant visceral disorder or of pressure on the spinal cord. This approach eliminates patients with psychogenic pain Psychoneurosis leads to multiplicity and incompatibility in patients allegations, by contrast, the patient who describes a complaint that gives rise to next to-no signs, and then is found to have next to-no signs, must be believed.

and more attention should be paid to the patient s statements than to the x ray appearances

Clinical examination shows very little. The characteristic kyphosis is noted the limitation of movement is obvious but the joints are often so stiff that the active movements prove painless and only the passive movements elicit the articular pain

The only conservative treatment sometimes effective is sustained traction, repeated at such intervals (if it succeeds for the time being) as the symptoms warrant. Arthrodesis performed over a wide enough extent of the thorax is curative but seldom feasible.

8 LATERAL EROSION

Exactly the same mechanism occurs in longstanding severe scoliosis At the concave side, the intra-articular disc becomes worn through and bone touches bone painfully with the same local sclerosis but less pronounced osteophytes. Constant unilateral pain felt in the erector muscles of, usually, the lower thorax is the first symptom. The early stage of intermittent pain analogous to posterior bulging leading to anterior erosion is absent. Since the bulge is lateral, not posterior, and thus cannot press on the dura mater or a nerve-root, no symptoms arise until bone touches bone.

The pain is constant, aggravated by any exertion tending to compress the joints, relieved somewhat by a night s rest. Breathing is painless

The passive movements at the relevant spinal joints hurt, the stiffness is such that the active movements are grossly limited but more or less painless The resisted movements do not hurt. Sustained traction is the only conservative treatment worth attempting but often fails If the symptoms warrant, extensive operative fusion is called for

PATHOLOGICAL WEDGING

The bodies of the thoracic vertebræ become wedged as the result of a number of different pathological processes.

1. ADOLESCENT OSTEOCHONDRITIS (SCHAUERMANN)

This occurs at the lower half of the thoracic spine (and in the upper lumbar region). Between the ages of fourteen and eighteen, an osteochondritis may appear at the end-plate of one or two adjacent vertebræ, often the ninth and tenth thoracic. Osteochondritis is merely a descriptive label; as at other epiphyses, both the cause and the nature of the disorder are unknown. The end-plate disappears anteriorly and nuclear material erodes the now unprotected bone; wedging results. The process is painless and in itself insignificant, but it leads to a permanent increase in the degree of kyphosis at that joint. This posture tends to eventual retropulsion of disc-substance and posterior bulging due to compression (see p. 339) is apt to occur some or many years later.

The lateral radiograph (see Plate 12) shows the condition clearly, but since the disorder often causes no symptoms x-ray evidence of vertebral osteochondritis past or present must not be regarded as of any significance, unless the symptoms and clinical signs point to an articular lesion at the affected level.

I have never seen a case of Calvé's osteochondritis of the vertebral body itself with consequent wedging.

2. FRACTURE

Flexion injuries may cause fracture of a vertebral body. The immediate pain usually encircles the trunk at the appropriate level; this girdle pain lasts a week or two. At the end of three months symptoms have ceased, no treatment is necessary unless the patient is seen in the acute stage when a week in bed may be required. If the bone alone was damaged, no further trouble need be feared, but if the disc was damaged as well, or if fixed flexion deformity of the affected joints leads to a compression phenomenon (see p. 339), pain is apt to return, perhaps years later. Occasionally post-traumatic ossification in the ligaments leads to fixation of the joint and permanent cure.

The convulsion of E C.T. may, by hyperflexing the spine, drive the nucleus pulposus into the body of a vertebra. No

wedging results and slight and transitory pain in the bone from the minor fracture is the only symptom. The radiograph is diagnostic

3 SENILE OSTEOPOROSIS

This disorder affects the whole thoraco-lumbar spine and pelvis of elderly persons, more often women (see Plates 11 and 13) the neck and the bones of the limbs are not appreciably affected

The bodies of the vertebræ soften, hence the first radiological sign is a marked biconcavity of the vertebral body, caused by disc substance pushing its way evenly towards the spongiosum At this stage, *there are no symptoms* and it is a common mistake to suppose that, if a patient has backache and the radiograph shows senile osteoporosis, a lesion accounting for the backache has been found The same appearance is seen in young patients who once suffered from severe rickets, and in tropical osteomalacia. Later on pathological wedging may occur If this takes place suddenly, fracture with girdle pain results, leading after a week or two to localized bone pain. After three months, this has ceased unless the flexion deformity gives rise to retropulsion of the articular contents and a compression phenomenon. If the wedging takes place gradually, it may cause no symptoms, but in due course the compression phenomenon (see p 339) may ensue. When such symptoms occur for the first time in old age, palpation for the rounded kyphos should be followed by radiography

I have tried both testosterone and huge doses of calciferol in order to diminish the tendency to further collapse of one or more vertebral bodies, but serial radiographs taken over such a period of years show that neither therapy had a prophylactic effect. Cortisone increases osteoporosis.

4 PATHOLOGICAL FRACTURE

The angular kyphos is palpable and radiography shows the cause. When this is due to an isolated myeloma of the vertebral body, x ray therapy may be lastingly effective. Tuberculous caries demands immobilization followed by arthrodesis

5. SCHMORL'S NODES

These appear for the first time at about the age of sixteen at the lower thoracic and upper lumbar levels and represent small invasions of the vertebral body by nuclear disc-material protruding vertically. They never cause any symptoms, at the time of their occurrence or later. By diminishing the centrifugal force normally exerted on the annulus by the nucleus pulposus, they may well protect the patient against painful disc-lesions.

THORACIC SPONDYLITIS DEFORMANS

Realization that a patient's symptoms are the result of spondylitis deformans depends on examination of the whole trunk. The history may be suggestive, the aching coming and going as it will, without any connexion with exertion. The pain is central or bilateral, and occasionally, when the anterior longitudinal ligament is becoming affected, sternal instead of posterior. Difficulty in taking a deep breath may be mentioned, owing to rigidity of the thoracic cage.

A flat lumbar spine associated with an upper thoracic kyphosis is suggestive, and marked limitation of side-flexion in each direction at all the lumbar and thoracic spinal joints is pathognomonic. Sacro-iliac and lumbar involvement sometimes proceed painlessly; even so the lumbar spine becomes rigid before the thoracic joints stiffen. Since spondylitis deformans never starts after the age of forty, the restriction of lumbo-thoracic movement is found before the age when similar limitation from advanced osteophyte formation is apt to come on.

The radiograph of the sacro-iliac joints, not of the thoracic spine, is diagnostic.

Treatment consists of deep x-rays and the maintenance of movement for as long as possible at the costo-vertebral joints (see p. 352) and the prevention of eventual fixation in excessive flexion (see p. 507)

THORACIC SCOLIOSIS

A lower thoracic scoliosis is an important deformity; usually it first becomes perceptible at the age of ten. Slight

lateral deviation is noted when the patient stands upright, rotation is most obvious when the trunk is flexed and the posterior aspects of each hemithorax are found not to lie level. Upper thoracic scoliosis may result from a cervical rib, it seldom causes appreciable deformity A lumbar scoliosis is quite unimportant.

Once rotation has begun, it usually gets slowly worse whether expert treatment is instituted or not. Aggravation ceases when growth of the vertebræ stops. This is a very variable time, spinal growth may cease at the age of twelve or go on until eighteen Postural exercises, manipulation and plasters are all unable to diminish the deformity but it is difficult to say whether they may not have some effect in stopping its increase.

The child is usually first seen between the ages of eleven and fourteen and the important decision to arrive at is the amount of deformity yet to develop If this is slight, nothing need be done if this is considerable, the deformed part of the thoracic spine should be fused at once in the best possible position. Operation is not, of course, a suggestion welcomed by parents, and they need convincing

The relevant points are

1 The age and sex of the child Men's clothes hide a deformity far better than women's. The intended occupation, if known, may have a bearing

2 Has puberty begun or not? Puberty initiates the closing of the epiphyses and the more sexually mature the child the better

3 The length of the trunk in parents and siblings Obviously if in parents and elder siblings the length of trunk is a good deal greater than the affected child's, he probably has a good deal of growth left to come in his spinal column.

4 How fast is the child growing now? Serial measurements with dates can often be obtained if not, they must be instituted forthwith

5 Are the scapulæ level? Marked asymmetry of the outline of the shoulders is an added disadvantage.

6 Do serial radiographs, when superimposed and viewed, show increase in the lateral deformities?

When these points have been assessed, a reasoned prognosis can usually be given A photograph should now be

5. SCHMORL'S NODES

These appear for the first time at about the age of sixteen at the lower thoracic and upper lumbar levels and represent small invasions of the vertebral body by nuclear disc-material protruding vertically. They never cause any symptoms, at the time of their occurrence or later. By diminishing the centrifugal force normally exerted on the annulus by the nucleus pulposus, they may well protect the patient against painful disc-lesions.

THORACIC SPONDYLITIS DEFORMANS

Realization that a patient's symptoms are the result of spondylitis deformans depends on examination of the whole trunk. The history may be suggestive, the aching coming and going as it will, without any connexion with exertion. The pain is central or bilateral, and occasionally, when the anterior longitudinal ligament is becoming affected, sternal instead of posterior. Difficulty in taking a deep breath may be mentioned, owing to rigidity of the thoracic cage.

A flat lumbar spine associated with an upper thoracic kyphosis is suggestive, and marked limitation of side-flexion in each direction at all the lumbar and thoracic spinal joints is pathognomonic. Sacro-iliac and lumbar involvement sometimes proceed painlessly; even so the lumbar spine becomes rigid before the thoracic joints stiffen. Since spondylitis deformans never starts after the age of forty, the restriction of lumbo-thoracic movement is found before the age when similar limitation from advanced osteophyte formation is apt to come on.

The radiograph of the sacro-iliac joints, not of the thoracic spine, is diagnostic.

Treatment consists of deep x-rays and the maintenance of movement for as long as possible at the costo-vertebral joints (see p. 352) and the prevention of eventual fixation in excessive flexion (see p. 507).

THORACIC SCOLIOSIS

A lower thoracic scoliosis is an important deformity; usually it first becomes perceptible at the age of ten. Slight

lateral deviation is noted when the patient stands upright rotation is most obvious when the trunk is flexed and the posterior aspects of each hemithorax are found not to lie level. Upper thoracic scoliosis may result from a cervical rib it seldom causes appreciable deformity A lumbar scoliosis is quite unimportant.

Once rotation has begun, it usually gets slowly worse whether expert treatment is instituted or not. Aggravation ceases when growth of the vertebræ stops. This is a very variable time spinal growth may cease at the age of twelve or go on until eighteen Postural exercises, manipulation and plasters are all unable to diminish the deformity but it is difficult to say whether they may not have some effect in stopping its increase

The child is usually first seen between the ages of eleven and fourteen and the important decision to arrive at is the amount of deformity yet to develop If this is slight, nothing need be done if this is considerable, the deformed part of the thoracic spine should be fused at once in the best possible position Operation is not, of course, a suggestion welcomed by parents, and they need convincing

The relevant points are

1 The age and sex of the child Men's clothes hide a deformity far better than women's The intended occupation, if known, may have a bearing

2 Has puberty begun or not? Puberty initiates the closing of the epiphyses and the more sexually mature the child, the better

3 The length of the trunk in parents and siblings. Obviously if in parents and elder siblings the length of trunk is a good deal greater than the affected child s, he probably has a good deal of growth left to come in his spinal column.

4 How fast is the child growing now? Serial measurements with dates can often be obtained, if not, they must be instituted forthwith

5 Are the scapulæ level? Marked asymmetry of the outline of the shoulders is an added disadvantage.

6 Do serial radiographs, when superimposed and viewed, show increase in the lateral deformities?

When these points have been assessed, a reasoned prognosis can usually be given. A photograph should now be

taken with the child bending halfway forwards, so as to show the degree of thoracic rotation. The parents usually prefer that standard manipulations and exercises for the correction of a scoliosis should now be carried out for six months. The patient is then photographed again and the family interviewed once more. If the deformity has increased, if growth shows no sign of abating and the child is in the early teens, operation should be advised. It is the photograph that convinces the parents of the necessity.

Operation means six months in bed while the graft unites and another six months in a plastic jacket. Hence it is not to be entered on lightly, but the alternative in mid- and lower thoracic scoliosis is often worse.

An alternative approach is offered by Engel's (1939) experiments. He applied radium to the left side of animals' spines and found that growth was inhibited unilaterally at the epiphysial line. Scoliosis resulted, concave towards the left. Further experiments on this foundation may lead to the development of a non-operative treatment for scoliosis in adolescence.

CONGENITAL SCOLIOSIS

I have no experience of this disorder in infancy and early childhood. Denis Browne (1951) states that the first sign is that the baby always lies twisted to one side, never to the other. The mother may notice that the ribs on one side of the chest are more prominent than on the other. As soon as he learns to sit up, body weight comes into action and the condition gets rapidly worse. Browne says that, for conservative treatment in his special splint to be effective, the diagnosis must be made in the first three months. The baby must not sit up until able to turn his back with equal facility in each direction. He goes on to say that " unless arrested either by early efficient treatment or by later drastic operation, it ends in the worst of all non-tuberculous deformities of the spine."

LESIONS *OF THE* THORACIC CAGE

The intrinsic thoracic muscles, notably the intercostal muscles, are liable to direct bruising. The muscles con-

necting scapula and humerus to the thorax may be painfully strained, especially in athletes Hence an essential part of the examination of the thorax is to test the resisted movements of the neck, scapula, arm, thorax and abdominal wall

It should be remembered that diaphragmatic, intercostal or abdominal muscular symptoms and signs, when accompanied by fever, may result from epidemic myalgia, less often from infestation with *Trichina spiralis*

INTERCOSTAL MUSCLES AND RIBS

Damage to one or more intercostal muscles follows direct bruising The ribs may or may not remain intact Fracture of a rib must involve some muscle fibres tearing close to the break. When there is no displacement of the fractured ends, these interdigitate and are not a source of appreciable symptoms The patient sometimes mentions painless clicking for a week or two hence, even if movement at the site of fracture does take place, it does not hurt. Nevertheless breathing and other active movements do cause pain, clearly of muscular origin

Referred pain does not arise from an intercostal muscle, for it is developed at the distal end of one short segment, moreover it lies superficially Injury is nearly always to an intercostal muscle on the front of the chest. The patient points to the spot in a characteristic way, he places one finger on the spot. In other painful affections at the thorax the pain is diffuse and he indicates the site of symptoms with the palm of his hand The main diagnostic difficulty is the nerve-root type of thoracic disc-lesion In the other types the pain is posterior as well as anterior and no confusion can arise. Full trunk extension performed actively stretches the affected muscle and resisted flexion and rotation of the trunk usually also hurt. Luckily these are the very movements that do not hurt a patient with a thoracic disc lesion. Palpation should be avoided if possible, since a tender spot can nearly always be found at the front of the chest wall in any case of disc lesion with anterior pain.

Medico-legal considerations apart, when the intercostal muscles are damaged by direct bruising it makes no difference whether an uncomplicated fracture of one or more ribs is

present or not. The cause of pain and the treatment are the same in either case.

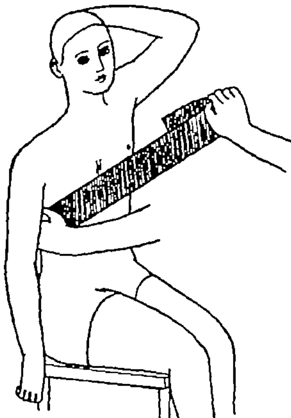
Clicking of a costal cartilage is painless. Momentary discomfort, however, is felt when the point of one of the lower ribs hits the iliac crest, as may happen on side-flexion of the trunk in patients with exceptionally long floating ribs or in marked scoliosis. Quite severe pain lasting as long as a minute occurs when the point of a rib becomes loose anteriorly and is forced into the substance of the abdominal muscles on trunk-flexion. The attacks are recurrent and the typical history leads to local palpation making the situation clear. The patient often supplies the diagnosis himself.

Treatment

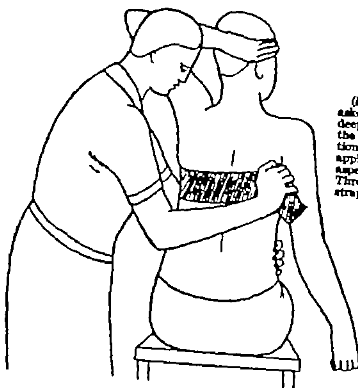
Muscles. The intercostal muscles respond very quickly to massage. Especially if he is elderly, the patient cannot mobilize the muscle himself however deeply he breathes, hence pain persists indefinitely, but the scarring is broken down by transverse massage in a very few sessions (see Vol. II).

Fractured Rib. As already pointed out, it is tearing of the intercostal muscle that sets up pain in uncomplicated fracture, not the broken ribs themselves. In recent cases the best immediate treatment is local anæsthesia induced at the affected muscles The pain on breathing may be such as to cause shock, which the anæsthesia immediately abates. The severe pain very seldom returns. Further relief from pain can be achieved by strapping the affected side of the chest. The criterion for its application is the degree of pain, not the fact of fracture, hence strapping is equally indicated in recent intercostal lesions, whether or not associated with fracture.

Non-elastic strapping is applied horizontally; it must cross the mid-line at the sternum and at the spine, and must be applied very tightly at the extreme of a full expiratory movement (see Fig. 51). Fractured ribs unite enough to become painless in four to six weeks and union is invariable; thus, pain persisting after this period has elapsed must arise in the intercostal muscles. Some cases of costal fracture cause such mild symptoms as to call for no treatment.



(a) The patient sits and broad non-elastic strapping is applied to the front of his chest, starting well beyond the mid-line on his uninjured side.



(b) The patient is asked to breathe out as deeply as possible. At the extreme of expiration, the strapping is applied to the posterior aspect of the thorax. Three layers of such strapping usually suffice.

FIG. 51.—Strapping for fractured ribs.

Spontaneous cure is to be expected in the young, because healing in the presence of movement is assured. It is not invariable, so should pain persist longer than a month, deep massage must be employed.

Loose Rib. If a loose rib or long floating rib causes sufficient symptoms, its anterior extent can be removed by a simple operation.

MUSCLE LESIONS

Minor Trauma to the Diaphragm

These cases are uncommon. They result from blows on the chest with transmitted stress. The pain is on respiration only; no pain is elicited when trunk movements are performed while the patient holds his breath. It is my impression that the central fibres of the diaphragm give rise to pain felt only in the shoulder and arm, whereas the fibres near the ribs give rise to local pain only.

I have encountered one case only of a painful scar occurring at the attachment of the diaphragm to the back of the xiphisternum. The spot was just within finger's reach. The symptoms had been taken for indigestion for ten years and treated by drugs and finally cholecystectomy. Deep massage to this point afforded relief that has now lasted four years. In tears of a few fibres of the belly of the diaphragm, healing in the presence of adequate movement must occur. Hence no treatment is required and spontaneous cure is achieved in ten to twenty days.

Stitch

This is supposed to arise from the diaphragm and may be an ischæmic phenomenon akin to claudication. When a young runner starts panting, pain at the lower costal margin comes on suddenly as he draws breath in, thus stopping inspiration to the full capacity. It may be a recurrent phenomenon, coming on at the same moment in race after race.

Examination of the patient between-whiles reveals no abnormality; after a race deep breathing hurts for a few minutes—nothing else.

It is alleged that keeping the arms into the sides during exertion postpones or avoids pain As a rule, nothing avails

Lesions of the Pectoralis Major and Latissimus Dorsi Muscles

These are dealt with in Chapter X, since they are muscles controlling the arm In the former case the pain comes on gradually and is felt in the pectoral area, usually spreading down the inner side of the arm to the elbow Full passive elevation of the arm stretches the muscle and hurts, resisted adduction also hurts but resisted medial rotation usually does not The best way to elicit pain in lesions of the pectoralis major muscle is to ask the patient to bring both arms horizontally forwards and then press his two hands together as hard as he can (see Fig 37) The two areas most often affected are the inner fibres just below the clavicle or the lowest part of the outer edge close to the ribs When the differentiation between an intercostal and a pectoral pain is required, and pain on a resisted adduction movement of the arm is not clearly elicited, the following test is useful. The patient places his hand on his hip and tenderness is compared while the pectoralis major muscle is in contraction and in relaxation In cases of a pectoral lesion the tenderness is greater on contraction The pectoralis minor muscle appears never to suffer comparable strain

Treatment consists of local anæsthesia and deep massage (see Vol. II)

When the thoracic extent of the latissimus dorsi muscle is affected, the pain is localized. Resisted adduction and full passive elevation of the arm both hurt the thoracic movements are painless Local anæsthesia often has some lasting effect but deep massage is quickly curative (see Vol II)

COSTO-VERTEBRAL JOINTS

Movement at these joints lessens as age advances, in consequence the respiratory excursion of the chest wall diminishes. Thus it is at and after middle age that minor

traumatic lesions of the intercostal muscles have to heal in the absence of adequate movement and result in chronic pain. A thoracic kyphosis, emphysema or a liability to asthma increases the tendency to early stiffness. In such cases, the joints should be kept as mobile as possible by passive forcing, whereupon the patient practises deep breathing exercises that maintain the added range. To this end the physiotherapist places her hands on the lower ribs and increases the respiratory movement of the chest wall by manual pressure (see Fig. 52).

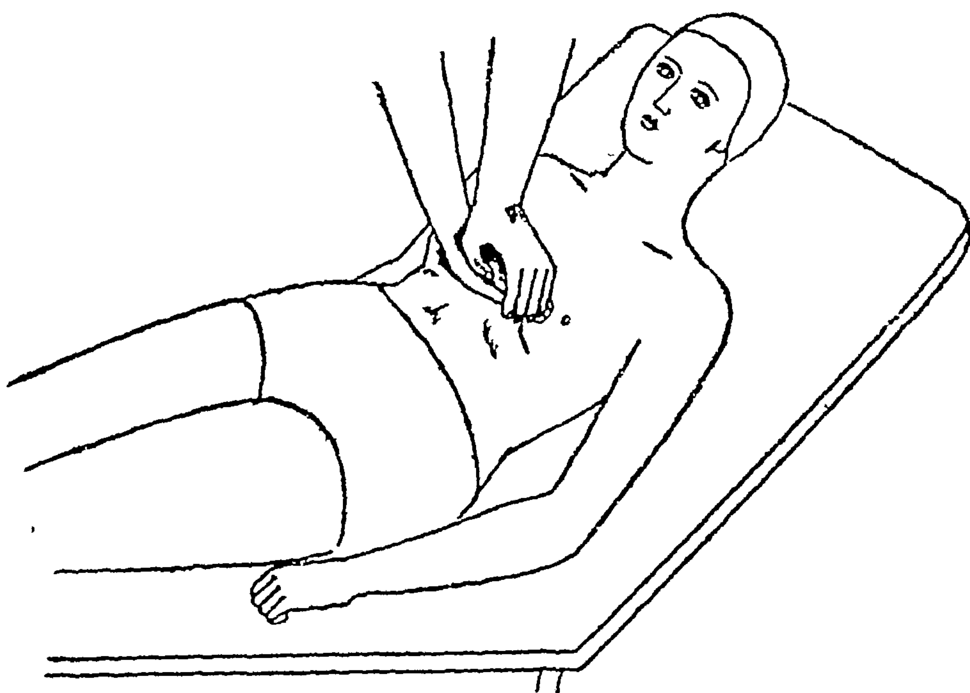


FIG 52—Assisted expiration. As the patient reaches the extreme of expiration, pressure is exerted strongly at his lower sternum. This mobilizes the costo-vertebral joints

In spondylitis deformans, the costo-vertebral joints eventually become ankylosed as part of the ossifying process. During the involvement, which may take years, pain is felt at one or both sides of the sternum or of the mid-thoracic region posteriorly. It is apt to be most troublesome after some hours' sleep or on waking in the morning, *i.e.* after relative immobility. Breathing is uncomfortable and the patient feels the respiratory excursion of his chest to be restricted—as indeed it is. The trunk-movements do not

alter the pain, but make the diagnosis clear, for side-flexion of the lumbar spine is largely or fully lost by the time the costo-vertebral joints are affected Pressure on the sternum while the patient lies supine reproduces the pain. Eventual fixation of the ribs is certain to occur but it should be postponed and the symptoms abated for the time being by the manoeuvres illustrated in Figs. 52 and 53 If such mobilization of the joints fails to bring relief from pain, x ray therapy is indicated

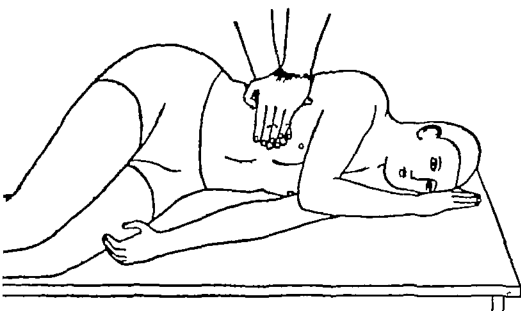


FIG 53.—Assisted inspiration. As the extreme of inspiration is reached, pressure is exerted on the lower ribs. This mobilizes the costo-vertebral joints in the opposite direction to that shown in Fig 52.

Post-operative posture and respiration provide an important field for the physiotherapist. The position in bed of the patient is most important, *e.g* after thoracoplasty After operations of any severity on the chest and abdomen, the vital capacity is much diminished Breathing exercises, postural drainage and manual shaking greatly diminish the incidence of post-operative pulmonary complications.

LESIONS OF THE ABDOMINAL WALL

An accurate and detailed history is the first essential in differentiating visceral disorders and thoracic disc lesions

from anterior muscular pain. Except in athletes or after an operation for inguinal hernia, anterior abdominal pain seldom results from a muscular lesion ; hence this ascription should be made with due care and unwillingness.

EXAMINATION OF ABDOMINAL MOVEMENTS

When the abdominal muscles are affected, little information is supplied by the trunk movements of the standing patient ; for only extension hurts in lesions of the abdominal musculature. The resisted abdominal movements are tested as follows :

The patient lies supine ; then, resting his hands on his

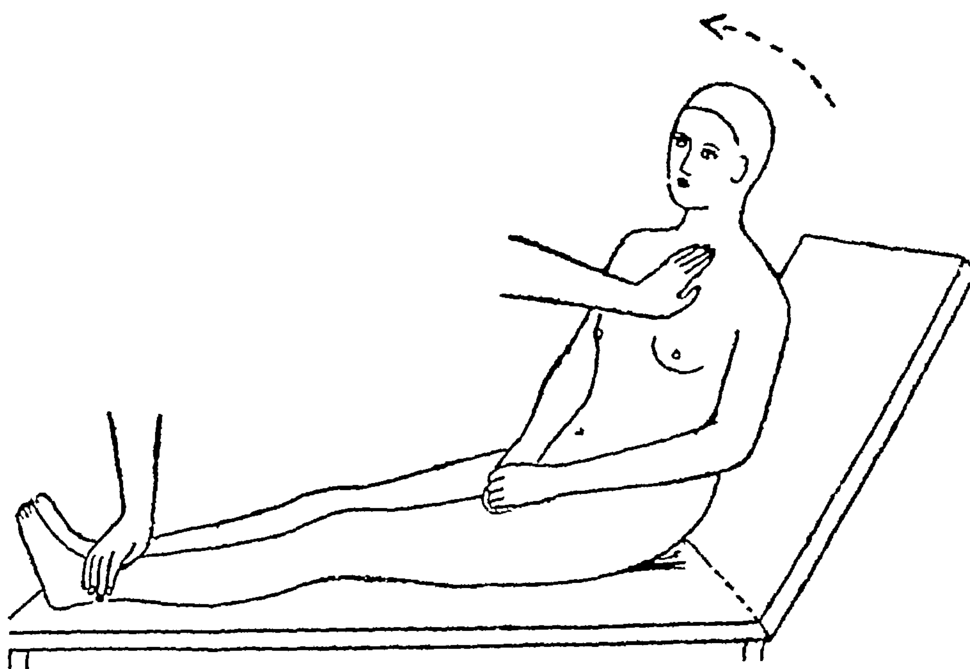


FIG. 54.—Resisted flexion of trunk The examiner supports the patient's legs with one hand while resisting the patient's attempt to sit up by pressure on his chest Test for the rectus abdominis muscle.

lap he sits up. The examiner places one hand on his feet and the other against his sternum, and a strong trunk-flexion movement is resisted (see Fig. 54). Pain on such resisted movement may be felt in the abdomen, in which case it arises from the rectus abdominis ; or in one groin, in which case it arises from the flexor muscles of the hip. The sitting patient is next asked to twist his trunk against the examiner's

resistance applied at both shoulders (see Fig 55) Pain on such a movement away from the painful side suggests a lesion of the external oblique muscle, towards the painful side, of the internal oblique muscle.

The structure singled out by the discovery of which movement proved painful should be examined for tenderness near the area where the pain is felt. If the rectus abdominis

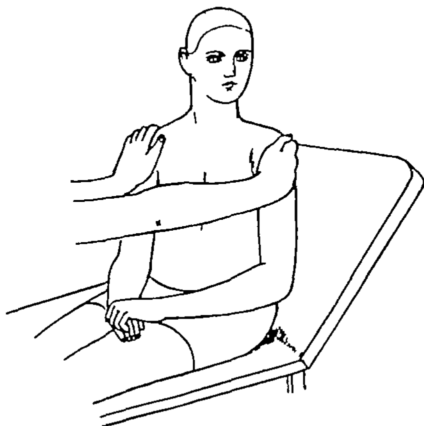


FIG. 55.—Resisted rotation of trunk. The patient tries to twist his trunk against resistance applied at his shoulders. Test for the oblique abdominal and serratus posterior inferior muscles.

muscle is at fault the lesion lies most frequently above the umbilicus. The patient is usually an athlete who describes a painful strain A small hæmatoma can often be felt. Tenderness at the pubic insertion suggests fracture or puerperal subluxation of the symphysis pubis rather than a muscular lesion

When the origin of either oblique muscle from the ribs is affected, tenderness is not readily elicited by pressure on

the front of the costal margin. It is by bringing the finger under the costal edge and pressing upwards and forwards that palpation—and for that matter massage—catches the fibres of origin against the bone. As some tenderness here is normal, the two sides must be compared with care. The belly of an oblique muscle is involved as a rule at one or other iliac fossa. Appendicitis may then be closely simulated. The following test serves to determine whether the source of pain is in the muscle or viscera.

The semi-recumbent patient is asked to raise his head and shoulders from the couch, *i.e.* to contract his abdominal muscles—and pressure is applied at the spot which has already been found to be tender. The patient is then asked to lie back and relax, and pressure of the same degree is applied again. If the pain is accentuated in the former event—namely, when the pressure is exerted against taut muscles which protect the underlying viscera—its source must be in the muscles or fasciæ of the abdominal wall. If, on the other hand, it is greater when the patient relaxes, the source must lie inside the abdomen.

Gross weakness of the abdominal muscles results from advanced myopathy or anterior poliomyelitis.

The treatment of muscle lesions of the anterior abdominal wall is deep massage (see Vol. II).

SYMPHYSIS PUBIS

Puerperal subluxation results in pain and tenderness felt exactly at the symphysis as soon as the patient gets up after the confinement. Resisted trunk-flexion sets up local pain (see Fig. 54). Radiography while the patient stands first on one leg [illegible] o [illegible] trates the laxity, which allows u[illegible] ent between the bone ends.

A tight bin[illegible] symptom-free (usually six w[illegible] the

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THE FEMALE BREAST

Retraction of the Nipple

Treatment should be undertaken during the seventh month of pregnancy The nipple should be everted until it is more prominent than the aureola and the expanded tip grasped between the thumb and two fingers. The physiotherapist shows the mother how to apply continued traction.

Lactation

Massage is ineffective in increasing the supply of milk and has been shown (Dingle, 1945) to enhance the likelihood of breast abscess. Painful congestion is very successfully treated by one or two doses of 0 5 mg stilbœstrol hence massage for this purpose has been abandoned

ANTENATAL AND POSTNATAL EXERCISES

Such antenatal exercises as are alleged to mobilize the sacro-iliac joints are at best valueless Luckily they do not have this effect, otherwise the patient would suffer pain in the buttock. They do however mobilize the lumbar spine largely towards flexion this is a real disadvantage. The actual labour in patients who have and have not carried out antenatal exercises is the same This has been proved by statistics emanating from several hospitals, including St. Thomas's. On admission to the labour ward the demeanour of the patient prepared by prenatal classes is, however noticeably happier and more confident, and it is clear that the explanation of the processes of birth and instruction in general relaxation that are given at these classes are most valuable Antenatal preparation includes teaching the patient conscious control of the levator ani muscle, in order that she shall voluntarily relax it during labour and have the feel of how to contract it afterwards Such instruction for primiparæ should be continued and extended to all hospitals.

Since so many women state that they first developed

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A tight binder is worn until the patient is symptom-free (usually six weeks).

The symphysis may be seen radiologically widened in the pubic osteitis that may come on one to two months after prostatectomy.

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Since so many women state that they first developed

backache soon after the birth of a baby, it is obvious that great care should be taken of the lumbar spinal joints during the puerperium. The beginnings of disc-protrusion are often laid down by prolonged severe stretching of the posterior longitudinal ligament in its lumbar extent by what I call "the nursing mother's position" (see Fig 56) Lying for days with a lumbar kyphosis endangers the only ligament that holds the discs in place, moreover, kyphosis is easily and comfortably avoided by a pillow well placed in the lumbar region (see Fig. 57). It is a further advantage if

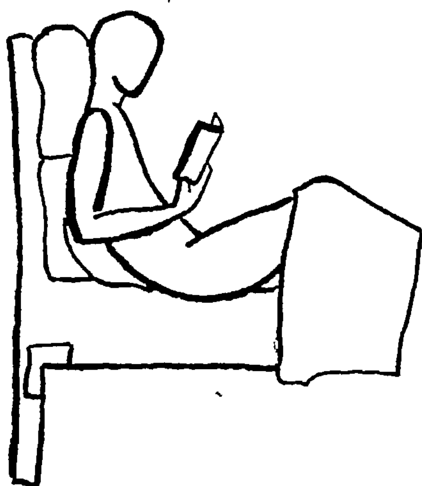


Fig 56—The "nursing mother's position" Note the lack of support at the lumbar region which remains in kyphosis all day long Disc-protrusion is thus encouraged

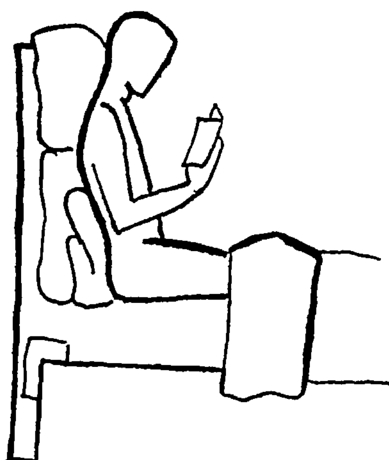


Fig 57—The correct way to sit up in bed A special pillow maintains the lumbar lordosis, and the posterior longitudinal ligament is spared

the patient turns to lie prone for several periods a day. Such simple attention to posture in bed is even more important in patients who have already suffered backache or lumbago.

Postnatal exercises contrast with the uselessness of antenatal exercises and are most valuable and should never be omitted; they should be begun on the day after birth unless some obstetrical contra-indication exists. In particular the levator ani muscle should have its strength quickly restored; for it suffers overstretching during labour and, unless its tone is restored by the time the patient gets up, the beginnings of retroversion, cystocele, stress incontinence and rectocele are laid down; much subsequent minor gynæcological

trouble would be avoided by active restoration of the pelvic floor during the puerperium.

Exercises for the equally overstretched and flabby abdominal muscles follow These should be performed statically or against resistance during lordosis rather than by active trunk rotation movements during flexion, so as to avoid damaging the lumbar spine Finally exercises to the quadriceps and foot muscles are given to maintain their strength until the patient gets up, and to the calf muscles in the prophylaxis of venous thrombosis

INTESTINAL SPASM

One effective, though elaborate and time-consuming treatment for spasm of the alimentary tract is vibratory massage (see Vol. II) It is scarcely worth discussing, however, for there exists only a handful of physiotherapists in this country capable of giving it.

CHAPTER XV

THE LUMBAR REGION

PART I · APPLIED ANATOMY

IN my experience lumbar disc-lesions are responsible for well over ninety per cent of all symptoms attributable to the lower back. This is a very different thesis from fifteen, or even ten, years ago. I was taught and believed, in common with all others, that affections of the muscles and fasciæ of the lumbar area were the usual source of pain. This idea sprang from Sir William Gower's lecture in 1904 when he postulated the existence of a disease called "fibrositis," which, attacking the fibrous tissues of the lower back, caused lumbago. This notion was accepted and remained unchallenged for forty-one years until a fresh approach to lumbago was put forward (Cyriax, 1945). "Fibrositis" was not debunked until three years later (Cyriax, 1948). "Osteo-arthritis" of the lumbar spine is now challenged in this book, but it was still considered the commonest cause of backache at the symposium held at the Mayo Clinic in 1951. Though my views were considered far-fetched at the time, the concepts set out in these two papers are now becoming enthusiastically adopted. But, as always, the pendulum has swung too far and the diagnosis of a disc-lesion is apt today to be made too readily at the lower part of the vertebral column.

There are a number of causes of pain in the back and lower limb other than disc-lesions. They are all uncommon and form a small group, dealt with in Chapter XVII.

THE ERECT POSTURE

The question may well be asked why disc-lesions are so common. It is a rarity for a patient to reach middle age without having developed attacks of internal derangement at one or more spinal joints. Why does ordinary use of the joints of the spine cause pain so readily, when the other joints of the body can withstand lifelong exertion without causing trouble?

The answer is, of course, man's acquisition of the erect posture The cerebellum has caught the vertebral column unprepared, the capacity to maintain equilibrium on two legs outstripping the evolution of the spine. As soon as man learnt to stand up, the function of the spine altered hence the whole column needed re-designing

In the long evolutionary period from fish to quadruped, the spine had served to maintain the distance apart of the front and hinder parts of the living creature It never had to bear any compression strain Since sagging of the spine as it hung between its anterior and posterior supports was undesirable, the column became a mechanism strong against extension stress As soon as the erect posture was assumed, the strains of compression and of flexion were imposed on a structure not designed to withstand either Worse still, the spinal nerves emerged opposite the weakest part of the column—namely the joints—instead of the exit for each pair lying (as might just as easily have happened) opposite the vertebral body Worst of all, each spinal joint (except the two uppermost) contained a disc a ring of fibro-cartilage with a pulpy centre. This arrangement, though mechanically unsound was harmless as long as the spine was horizontal and suffered only extension strains, since this tended to push the articular contents ventralwards, away from the nerve-roots. Cartilage cracks under stress and can wear away Moreover, having no blood supply it cannot unite or regenerate hence any damage done is permanent. Cartilage shares this inability to repair with brain and spinal-cord tissue only The function of these discs must have been to protect the central nervous system from vertical impact for they are not required by the joints as such. Indeed the two joints that bear the greatest weight are the ankle and the talo-calcanean As the patient walks, they stand alternately more than twice the compression applied to any lumbar joint yet they are both conspicuous for holding up perfectly for an individual's lifetime, in spite of the absence of any buffer Again no symptoms necessarily result from such complete erosion of disc-substance that the lumbar vertebræ lie in virtual apposition Hence it is most arguable whether the existence of the intervertebral discs does not cause more trouble than it prevents.

THE LUMBAR LORDOSIS

Many observers must have been puzzled—as I have been—by the fact that the spinal column, though a weight-bearing structure, has been designed in a series of curves rather than as a vertical pillar. Individuals are encountered who do possess a perfectly straight spinal column from sacrum to neck; they have a graceful carriage and move well. A straight vertebral column is therefore not impossible to construct. indeed general mechanical principles would suggest that at the spine as at the limbs, a vertical line is ideal for weight-bearing. Æsthetic considerations strengthen this view; for a straight back leads to an agreeable posture, whereas an exaggerated lordosis leads to prominence of the belly and buttocks. The opinion has thus been put forward on apparently logical grounds that the lumbar lordosis should be as slight in degree as possible.

It is my belief that the lumbar and cervical lordoses were developed in order to protect—albeit not with great success—the posterior longitudinal ligament from excessive strain. Biologically speaking, the development must be recent and subsequent to the emergence of the capacity to maintain the erect posture; for the spinal curves are absent at birth and during the first year of extra-uterine life. The spinal joints most subject to internal derangement are the sixth cervical and the fourth and fifth lumbar—the very areas of the spine where the normal lordosis is most marked. The thoracic kyphosis may thus be regarded merely as a compensatory mechanism whereby the erect position can be maintained in spite of lordosis above and below. As can be seen on any lateral radiograph of the spine, the existence of the cervical and lumbar lordoses means that the joint-space is wider in front than behind. In this way a slight pressure, directed forward, is constantly exerted on the intervertebral disc during weight-bearing. Figs 58 and 59 show the difference in angulation at the joint, when a normal subject holds his lumbar spine extended and then flexed. In patients with a flat spinal column, the intervertebral disc has no such protection, and it is noticeable that patients with a lumbar spine devoid of anterior convexity are more apt to suffer from backache than those endowed with a normal degree of

lordosis Clearly if the joint-surfaces lie parallel when the patient stands erect, a slight degree of trunk flexion begins

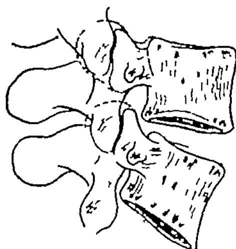


Fig. 58 —Lumbar extension. Tracing of a radiograph taken in trunk-extension. Note that the front of the intervertebral joint gapes widely ($\frac{1}{4}$ inch) whereas the posterior aspect narrowed ($\frac{1}{16}$ inch). When the articular surfaces are thus tilted, the pressure of the body weight forces the contents of the joint forwards.

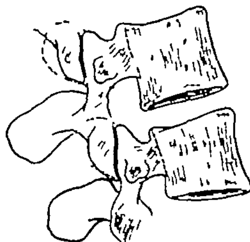


Fig 59 —Lumbar flexion. Tracing of a radiograph of the same individual taken during trunk-flexion. Note that the inclination of the joint surfaces is now reversed. The anterior aspect of the joint-space ($\frac{1}{4}$ inch) has now become less than the posterior ($\frac{1}{16}$ inch). The intra-articular contents now tend to be forced backwards. This is the dangerous tilt.

at once to squeeze the disc backwards, whereas the existence of a lordosis ensures that the trunk has to be well flexed before the back of the joint is wider than the front.

The phenomenon of a painful arc (see Fig 60) on trunk flexion throws light on intra articular mechanics Such a painful arc is pathognomonic of hypermobility of the intra articular disc in a spinal joint. When patients possessing a normal lumbar curve stand erect, the disc is held in its anterior position As trunk flexion proceeds, the moment comes at the half flexed position when the surfaces have tilted enough to make the back of the joint wider than the front. At this point, a mobile fragment of disc moves sharply backwards, jarring the dura by pressure transmitted through the posterior longitudinal ligament. Further trunk flexion may not alter the position of the disc again the remainder of flexion is then painless. Alternatively the pain may

by many medical men, is an obvious misconception; for not only do many people with "good" posture suffer from backache but an equal number with a "bad" posture do not. There is only one posture that enhances the likelihood of backache—namely, a flat back—and it so happens that this is the very one regarded for years as "good."

Backache arises, whatever the posture—good, bad, or indifferent by æsthetic standards—as the result of some lesion. The diagnosis must state the nature of this lesion, and name the tissue responsible for the pain. "Postural" does neither. Posture is an idea; it is a shape. At most the use of this adjective suggests that, on account of some posture, an unidentified structure has been strained or compressed. This is not a diagnosis until the tissue at fault has been named.

Backache may alter with posture; in other words, the pain alters as the stress on one or other lumbar structure is altered. This is a characteristic of all pains arising from any moving part; for example, different positions of an arthritic joint induce variations in symptoms. In, say, tuberculous caries of the lumbar spine, one posture may be found more painful than another. If on this account the pain is called "postural" nothing very illuminating has been stated; for the most that this adjective can be held to explain is that the pain due to the lesion, whatever it is, alters with the position of the affected part.

THE STRUCTURES OF THE BACK

The many different ideas about backache are mostly dependent on ignorance of the mechanics of the lumbar region The application of simple anatomical fact to the problem of backache is set out below.

THE INTERVERTEBRAL DISC

Cartilage and Pulp

The disc consists of two parts, the nucleus pulposus and the annulus fibrosus. The disc is held in the slight cup formed by the concavity, above and below, of the two adjacent

surfaces of the vertebral bodies. The nucleus has the consistency of wet sand and during weight bearing exerts a constant centrifugal force on the annulus fibrosus In the normal state, the annulus is attached to the posterior and anterior longitudinal ligaments, and to the edges of the joint. By the time that the annulus has cracked, however, the fragment has detached itself and lies loose within the joint cavity

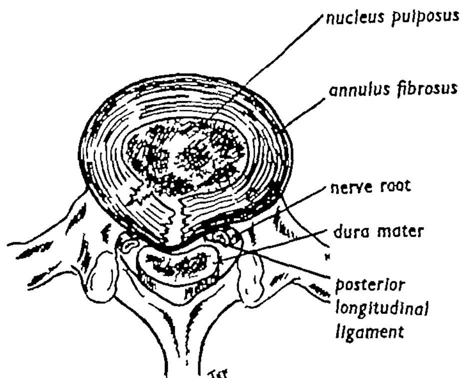


FIG. 61 —Cartilaginous disc-lesion. An annular crack has led to posterior displacement by hingeing The posterior longitudinal ligament is bulged out backwards and pressure exerted on the dura mater; lumbago results. No nuclear material has extruded; hence reduction by manipulation is simple.

Hence at laminectomy all trace of such adherence has often been lost. Provided that the annulus is intact, it cannot move enough to cause symptoms If it is cracked right across in one place it can hinge (see Fig 61) If it is cracked in two places a loose body composed of fibro-cartilage lies within the joint. At operation it is not very unusual to find three or four such loose fragments lying free

The nucleus sometimes pushes past the annulus if so, pure herniation of pulp with an intact annulus results (see Fig 62) If the annulus is cracked and part of it moves,

the centrifugal force always acting on the nucleus pushes pulpy material into the breach. As a result, any cartilaginous displacement of sufficient size and standing becomes aggravated by secondary herniation of pulp into the gap. This may take the shape of a collar-stud, the narrow track at the annulus forming the stem of the stud.

The capsular ligaments, strengthened in front and behind by the anterior and posterior longitudinal ligaments, confine the intra-articular contents. The existence of this central posterior reinforcement has an important practical result, for it ensures that the capsule of the joint is strongest at the

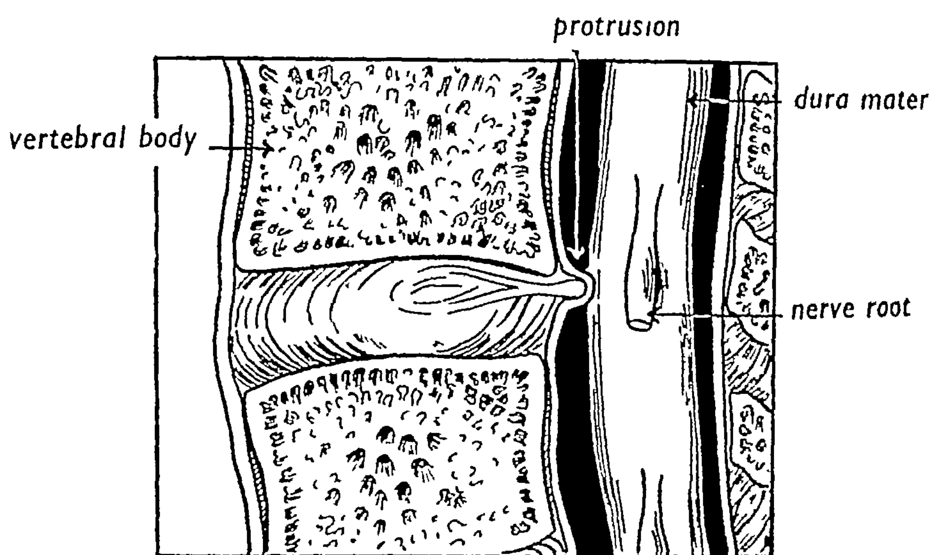


FIG 62—Pulpy disc-lesion. Nuclear material has pushed past the intact annulus and is bulging the posterior longitudinal ligament backwards until the dura mater is pressed upon (after R H Young) Backache or lumbago results Reduction by manipulation is often impossible; the treatment of choice is sustained traction

mid-line. Hence a protrusion, initially presenting centrally, is held back by a tough ligament; but the capsular ligament is deficient at the sides and the protrusion tends therefore to move postero-laterally. As a herniation enlarges it thus tends to become unilateral, *i.e.* to form a bulge in the region of the nerve-root rather than, as at first, close to the dura mater. This is what has happened when a patient, after an attack of lumbago has appeared to be subsiding, develops sciatica.

If the ligament at the back of the joint becomes stretched, hypermobility of the disc results and the beginnings, as yet painless, of disc-protrusion are laid down. Since the articular



PLATE 13

Senile osteoporosis. Note the extreme degree of rarefaction of the lumbar vertebræ contrasting with the calcified areas in the aorta. There were no symptoms.



PLATE 14

Circular disc-protrusion Ligamentous pull has led to osteophyte formation seen both anteriorly and posteriorly at the fourth lumbar level There were no symptoms



PLATE 16

Anterior disc-protrusion The fifth lumbar disc has been reduced to rubble and the intervertebral bodies lie in contact Remaining disc-substance has become displaced forwards, where it lies enclosed by the two huge osteophytes that have formed in consequence of the traction exerted by the anterior longitudinal ligament Since the protrusion does not impinge on a sensitive structure, for many years nothing is felt, finally compression causes the "mushroom phenomenon" (see text).



PLATE 17

Spondylolysis. Fibrous defect at the isthmus of the third lumbar vertebra without the deformity of spondylolisthesis. The patient was a woman aged 40 who had suffered from three years backache. Though the radiograph suggests that the symptoms are due to a secondary disc-lesion, examination showed capsular stretch to be responsible.



PLATE 18

Spondylolisthesis at fourth lumbar level This patient was a waiter whose deformity remained symptomless until it gave rise to bilateral sciatica at the age of 64 years

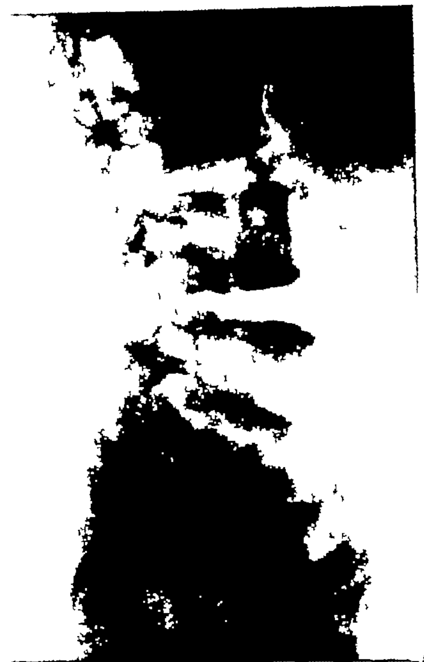


PLATE 10

Spondylolisthesis at the lumbo-sacral joint. The patient had suffered for twenty-five years from pain and paræsthesiæ in his right lower limb after standing for some time. As soon as he sat down the symptoms disappeared. Note the forward displacement of the fifth lumbar vertebral body on the sacrum and the long pedicle. There was no complaint of backache. The sciatica was ascribed to stretching of the fifth lumbar nerve-root against the shelf formed by the upper edge of the sacrum.



PLATE 18

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Spondylolisthesis at the lumbo-sacral joint. The patient had suffered for twenty five years from pain and paraesthesiae in his right lower limb after standing for some time. As soon as he sat down the symptoms disappeared. Note the forward displacement of the fifth lumbar vertebral body on the sacrum and the long pedicle. There was no complaint of backache. The sciatica was ascribed to stretching of the fifth lumbar nerve-root against the shelf formed by the upper edge of the sacrum.



PLATE 20

Posterior spondylolisthesis at the third lumbar level This followed a laminectomy at which the lateral articulations had been encroached upon. This patient had suffered several years' bilateral root-pain at the front of the thighs

surfaces of the joint are almost parallel, the disc, if damaged, can occupy an indefinite number of positions. The situation is not the same as at the knee where the loose fragment of meniscus lies at one or other side of the dome of the femoral condyle, i.e. either "in" or "out." If the posterior aspect of the capsule wears right through, disc-material is extruded into the central vertebral foramen. Far from leading as might have been thought, to natural cure, so little space exists here that this event serves only to aggravate the condition. Mr Harvey Jackson has even described a case to me of erosion of the theca as well, in consequence he had to extract fragments of fibro-cartilage lying free amongst the roots of the cauda equina.

Cases have been described of lumbar puncture being followed by lumbar disc-lesions. I am very doubtful whether the introduction of the needle bears any relevance to the disorder for, were it a question of extrusion of nuclear material via the puncture in the posterior longitudinal ligament, manipulative reduction would prove impossible. In fact, manipulative reduction usually succeeds, and it is clearly the flexed position in which the patient has been maintained, not the needle itself, that has caused the displacement.

Radiology Degeneration of a disc, once it becomes considerable, is shown as a diminished joint space on the radiograph It takes many years' erosion of the disc before the vertebral bodies can be seen to lie closer together than is normal When a disc is ground to pieces entirely, the joint space disappears and bone all but touches bone, only thin articular cartilage intervening (see Plate 15) If the disc is reduced to rubble and passes anteriorly, its remnants can be seen lying enclosed by two huge bony beaks (see Plate 16) The nucleus can herniate into the body of a vertebra, this phenomenon causes what are known as Schmorl's nodes Complete absence of the joint space is compatible with painless function but not with a full range of movement. The fact that the joint space is of normal or diminished width does not indicate where the posterior—the important—part of the disc happens to be lying Hence the appearance of the disc-space on the radiograph adds nothing for or against a clinical diagnosis of displacement of a disc-fragment. When a firm diagnosis of a disc-lesion is made, the fact that this or that

joint space is diminished or is the site of spondylolisthesis does not even prove that the lesion lies at the suggested level. For example at laminectomy for sciatica it sometimes happens that a patient's symptoms are the result of protrusion at, say, the fourth level (where the joint space is of normal width) and the contents of the fifth joint (where the space is much diminished) are not responsible for any symptoms, fragmentation having gone on silently for years. Moreover, some twelve per cent of patients subjected to laminectomy are found to have two protrusions (R. H. Young), not necessarily conforming in level to the radiographic appearances. Markedly diminished joint spaces at the upper lumbar levels are often seen in elderly patients who have never had any trouble with their back. Erosion of disc-substance leads to considerable loss of height as age advances. Calcification of a disc has no pathological significance.

Contrast Radiography. Myelography is not worth undertaking in lumbar disc-lesions; for these are much easier to detect clinically than radiologically. Only the larger protrusions are likely to show; these are already obvious clinically. Myelography should be reserved for cases in which the physical signs suggest a neuroma rather than a disc-lesion (see Plate 29). Discography (Lindblom, 1951) is an interesting novelty. Diodone is injected intra-articularly by the same approach as for lumbar puncture; the contrast material outlines the joint cavity. The advantages of this technique are largely academic.

Response to Treatment. Cartilage is hard and its displacements, whatever joint of the body they occur in, are often susceptible of manipulative reduction. This should be carried out at once in all suitable cases so as to minimize ligamentous lengthening at the back of the joint.

Pulp is soft and often cannot be successfully manipulated back into place. If a manipulative attempt is made, the technique is different; sustained pressure replaces the sharp jerk, since it is now the intention to squeeze rather than to click the displacement back. Most pulpy protrusions are reducible only by traction or by rest in bed.

Spontaneous Recovery

It is a curious fact that no matter how long a disc-lesion exerts pressure in the mid line posteriorly no particular tendency to spontaneous cure is manifest whatever the spinal level This includes cases of bilateral root pain The moment the protrusion moves to one side compressing a nerve-root with easing of the pressure exerted on the dura mater a mechanism leading to spontaneous symptomatic recovery is set in motion This takes six to twelve months at the lower three lumbar levels two to four months at cervical and uppermost thoracic levels; but does not operate at the third to twelfth thoracic levels. Time must be counted from the first appearance of strong root pain coupled with cessation of central pain in the trunk mere minor aching in the limb does not suffice and the time that has elapsed since gluteal or scapular aching began is wholly immaterial. The more marked the neurological signs, the sooner does the root pain abate

There are four ways in which spontaneous recovery is secured; the anatomical result in each case is different.

1 *Recovery without Anatomical Restoration.* Though the patient's symptoms have entirely ceased and straight leg raising is of full range and painless, the myelogram when repeated shows the protrusion to remain in its displaced position. This also happens at the neck (see Plate 8) If the displacement persists but the mobility of the nerve-root has been restored together with considerable or full recovery of the palsy the change can be only in the nerve-root itself This one must suppose, accommodates itself to the changed local anatomy by stretching The concept of the root stretching receives some substantiation from the fact that in postero-lateral protrusions spontaneous cure is the rule, whereas as long as the protrusion is posterior and central, it can go on giving rise to pain indefinitely In other words the nerve-root can stretch to accommodate itself to altered circumstances, the dura mater anchored as it is in the mid line by nerve-roots issuing above and below cannot.

2 *Reduction* The displaced part of the disc may return to its bed spontaneously, either during rest in bed or merely because the patient maintains his lordosis once he finds that

flexion is painful. Restoration of the *status quo* naturall means that the damaged tissue can move again; recurrence are thus to be expected.

3. *Erosion.* A large postero-lateral protrusion (see Fig. 63) pressing against a nerve-root lies in close contact with the dura mater. This pulsates, and jolts the protrusion against the back of the vertebral body at each beat of the heart. What happens is analogous to water wearing away a stone. The bone is eroded (as occurs on a larger scale in an aortic

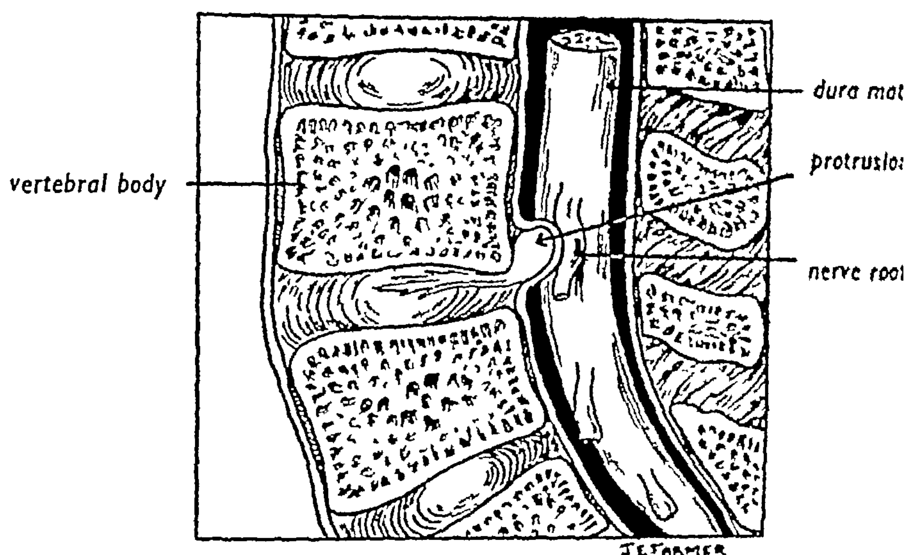


FIG. 63.—Sciatica caused by herniation of pulp at the fourth lumbar level. The protrusion has passed postero-laterally and now impinges on the nerve-root (after R H Young) It no longer presses on the dura mater hence the backache ceases when the pain in the limb comes on

aneurysm) painlessly and the protrusion is finally accommodated (see Fig. 64). I am indebted to my colleague R. H. Young for explanation of this important phenomenon. The protrusion now ceases to compress the nerve-root and the patient recovers fully. What is more, the protrusion now lies in a position from which it cannot become dislodged, and I regard patients in whom recovery has been awaited as the result of this mechanism as no more subject to further attacks than a normal individual. Hence they can resume heavy work

4. *Root-atrophy.* Root-pressure from a protruded disc goes on hurting as long as the sheath of the root remains sensitive. Extreme pressure so deprives the compressed extent of root-

sheath of its blood supply that it loses its sensitivity Pain thus ceases as straight leg raising becomes of full range the root palsy becomes complete. In other words, in proportion as the symptoms abate, the severity of the root palsy increases When pressure of this degree has supervened, though good functional recovery is to be expected some lasting



FIG. 64—Spontaneous recovery The postero-inferior aspect of the vertebral body is eroded and the protrusion accommodated (after R. H. Young). When this process becomes complete, dura mater and nerve-root are no longer subjected to pressure. Symptomatic recovery is now established.

muscular weakness and cutaneous analgesia are inevitable There is no liability to recurrence, for the protruded material never returns to its original site

THE MUSCLES

It is an accepted orthopædic principle that the stronger the muscles about a joint, the more stable it is. This is a sound generalization, but there are exceptions. This principle does not apply to the lumbar spinal joints, as anatomical considerations dictate for stability here is determined only by the interlocking of the lateral facets and the strength of the many ligaments. The sacrospinalis muscles lie along the postero-lateral aspects of the vertebræ hence the first effect of their contraction is to pull these bones together thus compressing the intervertebral joints Only when all the play in these joints has been taken up is the spine moved towards extension

An extension movement from the standing position is initiated by the sacrospinalis muscles As soon as the thorax

passes behind the vertical line the movement continues by the force of gravity. The abdominal muscles pay out to allow the movement to be carried to its extreme. Pain is elicited at the extreme of range by stretching, not as the result of active contraction of muscle. For this reason the standing trunk movements must be regarded as tests largely of articular function. If pain of muscular origin is suspected, the spinal movements must be tested against resistance with the patient lying on the couch. In fact, myofascial lesions are uncommon and result from direct trauma only. The reason is simple. The range of movement at the lumbar joints is small and the strength of the muscles considerable. Hence if severe strain falls on the back, the joint always gives way before the muscle.

When an individual bends forward to pick up a heavy object, the sacrospinalis muscles pay out and at the extreme of range are fully stretched. When he strains upwards to lift, three forces act on the lumbar joint while it is held in flexion. First, as soon as the lumbar spine passes the horizontal line, the weight of the trunk begins to compress the joint; secondly, the weight of the object lifted compresses the joint further; thirdly, both sacrospinalis muscles contract and compress the joint further still. Hence the stronger these muscles are, the greater the compression stress on the joint—in other words, the more liable to a disc-lesion he is made. The situation is the opposite of that at most other joints. This point is clearly not appreciated at present; for, though flexion exercises are falling out of favour now, there is hardly a hospital in the country where back exercises (perhaps supplemented by faradism) of some sort are not carried out in the "treatment" of disc-lesions. Though patients do recover in spite of such exercises, convalescence is delayed, and renewed protrusion during their performance—even if they are merely prone-lying trunk-extension exercises—is by no means unknown. I regard prone-lying triceps exercises ("press-ups"), *i.e.* passive extension of the lumbar spine without weight-bearing, as free from this objection, and called for if the patient's repeated attendance at hospital is for some reason advantageous.

Extension exercises are performed after laminectomy for the sake of the muscles themselves; not the joints. At the

beginning of the operation the sacrospinalis muscles are stripped off the sides of the spinous and transverse processes Naturally these muscles must be kept mobile while they are re-attaching themselves to bone during the post-operative period Believers in "fibrositis" should consider the very slight discomfort that extension exercises cause at the very time when inflammatory repair of the insertions is at its peak. They should also realize the full and painless function of which these muscles are capable later on, although they are the site of gross deeply placed scarring

The psoas and the abdominal muscles are the flexors of the lumbar spine the former flexes the spine when the femur is fixed, the latter flex it when the pelvis is fixed In the standing patient, once the movement has been initiated by these muscles, it proceeds from the force of gravity, the ham string and sacrospinalis muscles paying out smoothly to let the trunk down

In acute lumbago the flexed position of the lumbar spine is maintained by contraction of the psoas muscles which act in a manner analogous to the hamstring muscles in internal derangement at the knee.

As a result of this flexed posture, the sacrospinalis muscles have to work hard to keep the standing patient as erect as may be. This fact accounts for the idea fundamentally mistaken, that lumbago results from spasm or "fibrositis" of the sacrospinalis muscles. One has only to remember that these muscles *extend* the lumbar spine to realize the funda mental error The debunking of "fibrositis" has led to efforts to put forward more plausible lesions of the non articular structures Fatty lobules are present in the sacro-spinalis muscles and their herniation through the lumbar fasciæ with strangulation has been postulated as a cause of symptoms. Their actual existence in most normal persons is not denied Alternatively the word "fibrositis" has been changed to fascitis myogelosis, or non articular rheumatism" That the muscles, fascia and fatty lobules are not affected in lumbago is proved again by the patient's posture were any of these soft tissue disorders really present he would instantly relieve his pain by bending backwards and relaxing tension. Indeed the mere fact that a pain in the back or buttock is increased on bending backwards

shows that it arises from a joint and not from the extensor muscles.

THE BONES

The antero-posterior stability of the lumbar spine depends largely on engagement at the two lateral joints of the articular facets of one vertebra against the corresponding pair above and below (see Fig. 65). If the pedicle is lengthened (see Plate 19) or a fibrous defect replaces bone at each isthmus

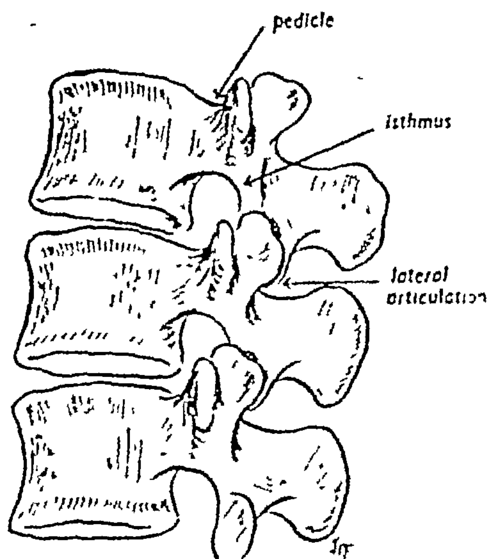


FIG. 65—Antero-posterior stability of the lumbar spine This depends on the integrity of pedicle, isthmus and the engagement of facets at each lateral articulation.

between the superior and inferior articular processes, this security is endangered. Plate 20 shows the considerable displacement that can occur after excessive removal of bone at laminectomy. In some cases, no untoward stretching takes place, and the condition is known as spondylolysis (see Plate 17). However, the fibrous tissue at the defect in the bone may lengthen; spondylolisthesis results (see Plate 18). Since the stretching takes place antero-superiorly to the lateral articulations of the affected vertebra, the spinous process of the spondylolisthetic vertebra is held in its normal relationship to that of the vertebra below. The body of the vertebra above, however, follows the body of the affected vertebra, and its spinous process therefore lies dis-

placed anteriorly For this reason, the irregularity of the spinous processes visible and palpable in spondylolisthesis appears at the vertebra above that shown on the radiograph to be at fault.

Congenital Abnormalities

Those who regard any congenital abnormality visible on the radiograph as sufficient explanation for backache are getting less numerous Different observers have noted between fifteen and thirty per cent incidence of congenital abnormality in the lumbo-sacral region of patients not subject to backache. Sacralization of the fifth lumbar vertebra has a negative significance since it shows this joint to be unduly stable and suggests that added strain has thus fallen on the fourth lumbar joint. Spina bifida occulta is a defect of the neural arch and thus unconnected with any joint it has no significance Neither has a lumbarized first sacral segment. "Osteo-arthritis" of an abnormal joint between the upper surface of the sacrum and the fifth lumbar transverse process is also symptomless.

By contrast spondylolysis and spondylolisthesis (see Plates 17 and 18) are significant, since they may result in painful stretching of capsule or nerve-root, or in a disc-lesion at the unstable joint. Spondylolisthesis can exist for a life-time without causing any symptoms

Of itself, hemivertebra causes no symptoms. Spontaneous correction above and below the angulation often leads to minimal postural deformity, though the radiographic appearances are most asymmetrical Hemivertebra may lead to a secondary disc-lesion at the oblique joint. Alternatively it can eventually result in the same painful bony contact of the vertebral bodies as complicates longstanding scoliosis from any other cause (see p 341)

THE JOINTS

The axis about which antero-posterior movement takes place lies at the junction of the anterior two-thirds and the posterior third of each lumbar vertebral body

The primary movements at the lumbar joints are flexion, extension and side-flexion Flexion is brought to a stop by the interspinous ligaments, the ligamentum flavum and the

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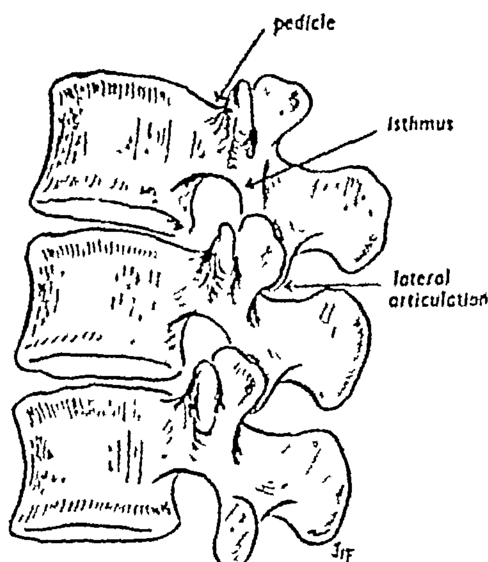


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THE JOINTS

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The primary movements at the lumbar joints are flexion, extension and side-flexion. Flexion is brought to a stop by the interspinous ligaments, the ligamentum flavum and the

capsule of the lateral articulations, which prevents the facets sliding any farther apart The posterior longitudinal ligament scarcely limits flexion; for it lies only just behind the pivotal point of the movement. Extension is limited by the abdominal muscles, the anterior longitudinal ligament, the capsule of the lateral joints (limiting approximation of the facets), and the engagement posteriorly (cushioned by the interspinous ligaments) of the spinous processes. Side-flexion is limited by the deep lumbar fascia and the lateral aspect of the capsule of the intervertebral and lateral joints

Only a very little rotation takes place at the lumbar joints. Rotation through 90° in each direction occurs at the thoracic joints, where the lateral facets all lie in the coronal plane so as to facilitate this movement. At the lumbar spine, engagement of facets on the side away from which the trunk is twisted largely prevents rotation. A little capsular play exists at the other lateral joint and slight shearing play also exists at the intervertebral joint; hence it is an exaggeration to say that rotation is wholly absent at the lumbar spine. Nevertheless, the range is very small.

"*The Facet Syndrome*"

Some authorities regard the lateral articulations as a common source of backache; I do not. In the first place, the commonest cause of considerable osteo-arthritis in the lateral articulations is spondylolisthesis, in which there is often no backache. Gross incongruence of these joints must occur when the intervertebral joint-space disappears as the result of fragmentation of disc-substance. Yet many patients in whom the joint space has disappeared suffer no pain. Fracture, or collapse of a vertebral body in osteitis deformans, markedly alters the alignment of the lateral joints; again there is often no pain.

In theory, a patient in whom articular signs are present without muscle signs might just as well have a lesion of the lateral articulations as of the intervertebral joint to account for his symptoms If so, his pain would not cease for the time being after epidural local anaesthesia; it would not be lastingly relievable by manipulative reduction or traction; it could not give rise to pain on neck-flexion nor to limitation

of straight leg raising, it could not set up sciatica at a later date

Hence, though the mere discovery of articular signs at the lumbar spine cannot be held to incriminate one joint rather than another many considerations combine to show that the lateral articulations are all but insensitive and that marked incongruence and osteo-arthritis, though common occurrences, exist again and again without symptoms arising

The Ilio-lumbar and Lumbo-sacral Ligaments

These have an important bearing on patients' symptoms and signs. These ligaments anchor the transverse processes of the fifth lumbar vertebra to each iliac crest and to the sacrum They therefore restrict side-flexion which has a much smaller range at the lumbo-sacral joint than at the other lumbar joints The fourth lumbar joint is capable of great side-flexion, hence in a patient with a protrusion at this level the joint can gape so much that the displacement is accommodated In other words, he presents marked deformity and thus avoids pain The same degree of accommodation is not possible at the lumbo-sacral joint in consequence the deformity is slight but the pain severe

Lumbar "Osteo-arthritis"

"Osteo-arthritis" of the lumbar spine is an imaginary disease. Not only does osteophyte formation at the intervertebral joint cause no symptoms, but it is a benefit, and is the mechanism whereby pain in later life is prevented.

Capsular Insensitivity For the proper comprehension of backache, the most vital point to grasp is that the lumbar joints are all but insensitive. The analogy with the knee does not hold. Internal derangement of the knee hurts the sensitive knee-joint, which becomes the site of a painful traumatic arthritis. At the lumbar and thoracic joints internal derangement is of itself painless, since the capsule of the joint is insensitive to the pressure exerted by the displacement. *Pain in lumbar protrusions is wholly dependent on whether or not the displacement presses via the joint capsule on neighbouring sensitive structures* The most obvious proof of

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this surprising state of affairs is the typical history given by patients suffering from primary postero-lateral protrusion of disc-material (see p. 419). Though they have suffered internal derangement with capsular stretching at a low lumbar level from the first, they have not had, and will not have during the whole evolution of their disorder, one moment's backache. The symptoms are felt only in the lower limb throughout the whole course of the disease. Another proof is afforded by the induction of epidural local anæsthesia. None of the solution gets inside the joint; only the dura mater and its investment of the nerve-roots is rendered anæsthetic, yet pain disappears though the protrusion is still present.

Osteophyte Formation. Weight-bearing exerts a centrifugal force on the contents of each lumbar joint. After many years, centrifugal pressure bulges out the capsular ligament, especially laterally and anteriorly. Capsular traction lifts the periosteum off the edge of the bone; periosteum is the limiting membrane of bone. Just as traction on the plantar fascia at its calcanean origin lifts up periosteum, whereupon new bone grows in to fill the gap—calcanean spur—so does this familiar process affect the edge of the vertebral body. New bone gradually forms in the space between vertebra and periosteum, and in due course an osteophyte appears. The lumbar joint being insensitive, this is a painless process (in contrast to the effect at the heel). This osteophyte formation brings two benefits. First, it replaces soft ligament with hard bone and the disc becomes cupped in bone—a strong hindrance to further protrusion. Secondly, the osteophytes limit mobility, thus preventing the very movements that might otherwise have resulted in an attack of internal derangement.

Anyone who still imagines that lumbar osteophyte formation causes a painful condition known as "osteo-arthritis" should visit a clinic where middle-aged heavy workers, *e.g.* stevedores, are seen on account of a disorder unconnected with backache, say, renal calculus. He will see, on radiograph after radiograph of the urinary tract, gross osteophyte formation at all the lumbar vertebræ. Questioned, the patient states that his back has never troubled him. Sooner or later, heavy work results in lumbar trouble unless osteophyte formation comes into play as a protective mechanism.

Those who carry heavy weights for a living and whose vertebræ adapt themselves by throwing out osteophytes are able to go on with such work until late middle age those who do not develop "osteo-arthritis" suffer from disc-lesions in the end and turn to other jobs Admittedly, these osteophytes are not a perfect protection and an occasional case of discogenic pain is encountered notwithstanding marked osteophyte formation nevertheless, the combination is unusual The lumbo-thoracic spinal joints are not the only ones where osteophyte formation is symptomless (see p 80)

Schmorl's Nodes Another protective mechanism is the development of Schmorl's nodes. Unfortunately they are rarely seen where they are most needed, *i.e* at the fourth and fifth lumbar levels, whereas they are common at the upper three joints This radiographic appearance indicates that the nucleus pulposus has protruded vertically into the body of the vertebra. This proceeds slowly and painlessly greatly diminishing the centrifugal force exerted by the nucleus on the annulus Hence it tends to prevent the posterior herniations that do cause symptoms, but unhappily not at the very joints where such protection is the most desirable.

THE DURA MATER

This membranous tube runs from the foramen magnum of the skull to the lower level of the first sacral vertebra (see Plate 86) It keeps the spinal cord as far as the first lumbar level, then the cauda equina, floating in a fluid medium This liquid is continuous from ventricles to sacrum A vascular jolt, *e.g* coughing, affects the intradural veins as well as those of the choroid plexus and starts an impulse transmitted by the cerebrospinal fluid the whole way down.

Dural Mobility

The dura mater moves slightly in relation to the vertebræ it traverses This has been unwittingly noted in two classical signs of meningeal irritation—neck retraction and Kernig's sign. Extension at the neck relaxes the dura mater as much as possible, and has its minor counterpart in local pain brought

on by neck-flexion in a thoracic or a lumbar disc-lesion. Occasionally a large mid-thoracic protrusion actually limits the range of neck-flexion. Kernig's sign is merely another way of demonstrating limitation of straight-leg raising. The movement stretches the dura mater from below, via the sciatic nerve. These signs have been accepted for decades, but their mechanism has not been elucidated; for hitherto the dura mater has not been regarded as possessing a mobility of its own, independent of movement at the joints it spans.

Dural Sensitivity

The dura mater is often regarded as insensitive, chiefly because pricking the membrane during lumbar puncture is not felt by the patient. This is not an effective stimulus, any more than acupuncture of the intestine; yet no one denies the pain of colic. Severe pressure on, or stretching of, the dura mater is painful, as anyone who cares to examine patients can quickly prove to himself.

The main dural symptom is pain felt in the posterior aspect of the trunk on coughing; curiously enough, in the thoracic region, a deep breath evokes the pain better than a cough. It would not surprise me to learn that the severe backache that sometimes heralds anterior poliomyelitis arises from the dura mater.

The dural signs are: (1) pain in the back brought on by neck-flexion; (2) pain in the back set up by straight-leg raising. This pain may be further increased by neck-flexion. O'Connell (1956) made radiographic measurements in full flexion and full extension of the neck and his findings have confirmed these views. He showed that in full flexion the length of the front and back of the cervical spinal canal increased by 1·5 cm. and 5 cm. respectively, compared with full extension. Combined dural stretch and mobility within the neck alone must therefore amount to a mean of 3 cm.

Comment. In lumbar disc-lesions, surely the most remarkable feature of all is the fact that the symptoms, though caused by displacement within a joint, arise from pressure transmitted indirectly to the dura mater and not from any pressure exerted on the articular structures themselves. For

years everyone, myself included, finding that the lumbar movements hurt, had sought the common cause of backache in the bones, joints, ligaments, muscles, fasciæ—in other words, in the moving parts of the back. The least expected of all findings was that the intra-articular disc, invisible on the radiograph, should provide the prime cause of backache and that the dura mater, then thought to lie inert and insensitive within the spinal canal, should prove the sensitive structure whereby derangements of the spinal joints made themselves felt. Unless this dual ætiology of pain is understood it is not possible to make sense of the signs presented by patients with, *e.g.*, lumbago The articular protrusion is the primary cause of pressure it bulges out the back of the intervertebral joint where it interferes with mobility The capsule and ligament are very insensitive and nothing is felt until considerable pressure is exerted secondarily on the dura mater

Since the mechanism is dual the examiner would expect the physical signs to be dual too They are for it is possible both painfully to stretch the dura mater by traction exerted from a distance and painfully to force the protrusion against the dura mater by movement at the affected joint. Hence there are two sets of signs those of dural provenance and those attributable to the articular disorder For this reason the sub-title of my paper in 1945 was ' the mechanism of dural pain Though the suggestion made then that lumbago is caused by internal derangement of a low lumbar joint has now become widely accepted, it does not appear to me that the concept of dural pain has filtered through half so well Disbelievers were, and still are, invited to confirm or disprove this theory by the same method that I had used to convince myself—epidural local anæsthesia. Though lumbago is so common and the injection quite simple, I have noticed that those who disagree with me have none of them attempted this simple test on a series of cases.

Dural Reference

The mechanism of the production of pain in disc lesion is not merely an academic point for readers of Chapter III will remember that the manner of reference of pain from the

dura mater defies the rules of segmentation that all other tissues observe. False localizing symptoms are therefore a commonplace, and must not be allowed to deceive. For example, if patients with acute central lumbago at a low lumbar level are asked where the pain spreads to, they may describe radiation to any of the following sites: both sides of the whole abdomen below the umbilicus; both groins; up the trunk posteriorly to the lower thorax; down the front, outer side or back of both thighs. None of these symptoms has the slightest localizing value, and the clinician must remember that in lesions affecting the dura mater ordinary anatomical tenets are regularly transgressed. Difficulty arises when pain in one buttock (first lumbar dermatome), one groin (twelfth thoracic dermatome) or the iliac fossa (lowest three thoracic dermatomes) is set up by a low lumbar disc-lesion causing little or no concomitant backache. Renal pain, appendicitis or a lower thoracic disc-lesion are then closely mimicked and differential diagnosis becomes extremely difficult at times. The removal of the appendix in lumbago is not a rarity, and by no means an easily avoidable error. Luckily, epidural local anæsthesia provides a simple answer in all cases of doubt. By contrast, the area occupied by the root-pain in *one* lower limb is highly significant; for the affected dermatome is often clearly outlined.

THE LUMBAR NERVE-ROOTS

Obliquity

The lumbar roots emerge in pairs from the dura mater and reach the foramen of exit by passing downwards and outwards across the body of the vertebra and the postero-lateral aspect of the intervertebral joint. It is here that a protruded disc can impinge against them.

The downward slope of the lowest two lumbar nerve-roots has an important practical application. It is possible for a protrusion lying almost centrally at the fourth level to pinch the fifth root, whereas by presenting a little more to one side, it can compress only the fourth root (see Fig. 66). A larger protrusion can, of course, squeeze both roots. Similarly, a protrusion at the fifth level may affect the first sacral or

the fifth lumbar or both roots. Moreover, twelve per cent of patients have been found at laminectomy to have a lesion at both levels (R. H Young) A fourth lumbar palsy indicates that the lesion lies at the fourth level a first sacral palsy, at the fifth lumbar level, but a fifth lumbar palsy leaves the issue indeterminate Hence it is always best to confine the diagnosis to a statement on which root is affected

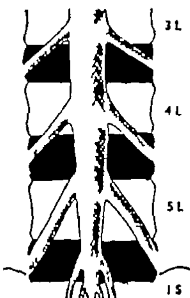


Fig. 66.—Relation of the lumbar nerve-roots to the intervertebral discs (black).

(From a photograph of a dissection: Burns and Young, "Lancet," 1945.)

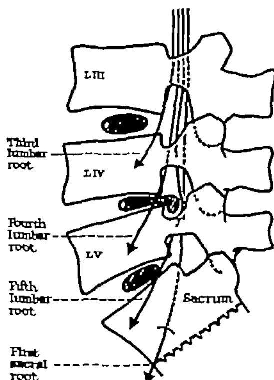


Fig. 67.—Compression of the fifth lumbar root by a protrusion at the fourth level. This diagram shows clearly that a herniation appearing just to one side of the posterior ligament misses its own nerve-root, since this had already passed too far laterally It is apt to impinge against the root emerging one level below

(After G. Laurence in "Revue du Praticien," 1952.)

Dural Investment

The nerve-root draws out with it an investment of dura mater that extends, judging by clinical data, for at least an inch The existence of this short sleeve derived from the dura mater was deduced (Cyriax, 1949) The anatomical studies of Frykholm (1951) confirmed its presence and post mortem specimens were illustrated (Brain 1954) delineating

the extent of the dural pouch. Hence reference of dural type is to be expected when a nerve-root is exposed to compression. Irritation at the axilla of the nerve-root leads to reference different from that set up by pressure exerted more laterally. Some patients describe this sequence: central lumbago, then pain in one buttock, finally pain in the lower limb accompanied by disappearance of the backache. This means that the protrusion lay centrally at first, squeezing the dura mater via the posterior longitudinal ligament and causing lumbar pain. Then it moved a little to one side, coming to press on the dural investment at the axilla; pain in the buttock resulted. Finally, when the protrusion moved a little further to one side, the nerve-root received the full impact. Hence the dura was liberated and the backache ceased as the pain in the lower limb became severe. Other patients, with primary postero-lateral protrusions, describe pain felt in the calf and posterior thigh only, the dura and its investment at the axilla of the root having never been compressed; hence, in spite of the purely lumbar situation of the lesion, there has been no pain in the back or the buttock. Many observers must have been puzzled to note that the fourth and fifth lumbar dermatomes start in the lower thigh; yet the pain of sciatica usually includes the upper thigh and buttock. These are sites of reference from the dural investment of the nerve-root to a theoretically impossible area. As also occurs at the base of the neck (see Chapter VII), dural non-segmental reference ceases as soon as the roots have joined to form the nerve-trunk. Thus pressure on the sciatic nerve in the buttock does not set up any local symptoms, but merely paræsthesiæ felt distally in a manner analogous to the thoracic outlet syndrome.

Sheath and Parenchyma

The nerve-roots consist of two parts, sheath and parenchyma, each with a different function.

Mobility. Each root has an external aspect—the sheath—which moves in relation to neighbouring structures. Experiments during laminectomy have shown that the lower two lumbar roots move through an ambit of a quarter of an inch during straight-leg raising. Restriction of mobility at

these two roots limits the range of straight leg raising since the sciatic nerve lies behind the hip and knee joints Restriction of mobility at the third lumbar root limits the range of prone-lying knee-flexion, since the femoral nerve

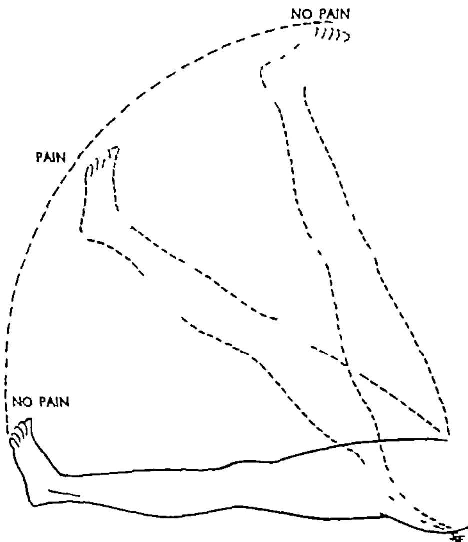


FIG 68.—Painful arc on straight-leg raising This is found when the nerve-root catches against a small projection, and passes over it.

lies in front of the hip-joint Moreover, the occurrence of a painful arc on straight leg raising (see Fig 68) shows that the nerve-root moves in relation to the posterior aspect of the joint A bulge here may form a projection against which the nerve catches if it is small the root slips over it, causing

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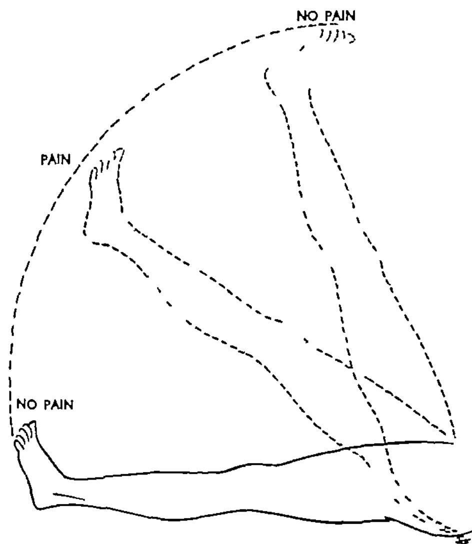


FIG 08 —Painful arc on straight-leg raising This is found when the nerve-root catches against a small projection and passes over it.

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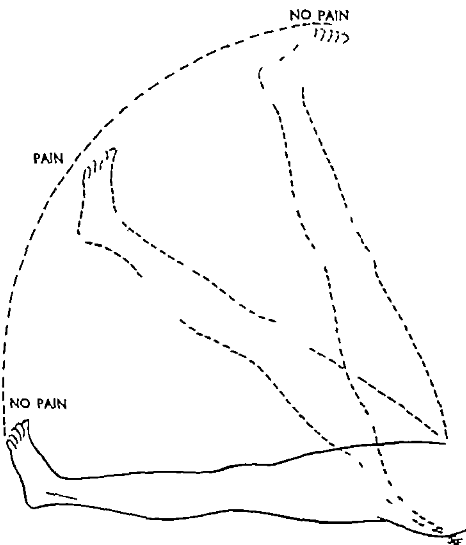


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CHAPTER XVI

THE LUMBAR REGION

PART II: EXAMINATION

THE examination of a patient complaining of backache follows a logical sequence. Inspection of the patient's appearance and gait, then of his trunk and lower limbs, is followed by observation of the range and painfulness or not of the active lumbar movements; then the sacro-iliac and hip-joints are examined. Next, the sheath of the lower three lumbar nerve-roots is stretched; conduction is tested and the presence or absence of arterial pulsation noted at the ankle. If there is any question of direct trauma to the back (or if the examiner believes in "fibrositis") the lumbo gluteal muscles are tested against resistance; finally the lumbar spine is palpated. Radiography follows. The function of every low lumbar structure has now been examined. Interspersed between these relevant observations, the cautious physician includes some tests to which ordinary patients' responses are uniformly negative. Moreover, he relates each finding with the previous observations, noting correspondence or discrepancies as he goes along. These precautions are particularly necessary in patients complaining of backache: for this is quite a common psychogenic symptom. Conducted in this way, the examination quickly singles out those who, given enough rope, put forward the self-contradictory patterns characterizing pain partly or wholly of mental origin. It also prevents the reverse error—namely, a mistaken diagnosis of psychogenic pain in an obviously neurotic patient with a genuine lesion.

As at the cervical joints, *the articular signs show whether or not internal derangement is present; the neurological signs then indicate which root is affected*. This happens to afford results less distinctive at the lumbar region than at the neck, partly because the segmentation of the muscles has a greater overlap, partly because of the oblique intraspinal course of the lower lumbar roots. Evidence of a third or fourth

lumbar or of a first sacral, root palsy has an unequivocal significance, but a fifth root palsy can arise from pressure applied either at the fourth or at the fifth level By contrast with the neck, additional help may be afforded by the patient's indications of the level of his pain If he points to the mid lumbar region or the iliac crest, the third or fourth joint is involved for fifth lumbar lesions give rise to symptoms felt at or below that level (except in acute lumbago)

Before the history is taken an important brief inspection is made. As the patient walks in, his gait is noted, and the presence or absence of the careful movements designating severe pain and the fear of agonizing twinges A glance at the patient's face gives the clue to how he has been sleeping and to how badly the pain is affecting him. Patients brought in on a stretcher may be suffering from lumbago or sciatica due to a disc-lesion but patients who attend in a wheel chair are usually suffering from spinal neoplasm or chronic osteomyelitis, for sitting is the most painful position of all in any disc-lesion

HISTORY

LUMBAR SYMPTOMS

A disc is damaged by prolonged wear and tear, it may also suffer in an accident. Should an annular crack be caused by an injury it may not become complete for a year or two Once it is complete, many months may elapse before the patient makes the movement that brings about displacement Hence a gap of weeks, months or years may separate the accident from its eventual, nevertheless direct, result This long interval between cause and effect causes great medico-legal difficulties and many patients suffer hardship if the possibility of so long a latent period is not kept in mind

No trouble must be spared to obtain from the patient a coherent account of what happened originally, what has hap pened since how the pain has varied with the years and during the course of each day where it has spread to, and what is its relation to posture, rest and exertion. The examiner bears two facts in mind First, that the patient is most

probably recounting the effect on him of events that took place inside a closed cavity situated at the mid-line of the body. Secondly, that pain results only when the intra-articular events cause indirect pressure on the dura mater or the nerve-root. Thus there is only a limited number of pressures possible. Since the lesion is so circumscribed, the most striking characteristic in patients' histories is their great similarity. Yet it is true to say *that there is no pain felt below the waist that cannot result from a low lumbar disc-lesion*. This fact owes its existence to misleading dural reference, and the physician must not fall into the common error (based, after all, on accepted anatomical fact) of, say, attributing a pain in the groin to a lesion at the first lumbar level.

The most obvious history describes attacks of recurrent internal derangement caused by a loose fragment of annulus. The patient states that he bent down; as he came up again he felt a click and was seized with severe lumbar pain, locking him in flexion. The pain is more often bilateral than unilateral. After some seconds or minutes he could straighten up but agonizing twinges prevented any but the most cautious movement, and coughing or sneezing was very painful. He retired to bed and the pain gradually eased, until, after some days or weeks, he was symptom-free. He remained so until a year or so later when a similar movement brought on the same train of events. The patient's account is the exact counterpart of internal derangement at the knee; a strain is followed by severe local pain and locking in flexion. A displacement lying at the back of his lumbar joint forces the patient to bend forwards, holding the joint in kyphosis so as to accommodate the protrusion. Erect he pinches the protrusion still further backwards, increasing the already painful pressure on the dura mater. Gradual reduction during rest in bed, *i.e.* during relief from the compression inherent in the erect position, follows the attack, but recurrence is very probable. Cartilage, having no blood-supply, cannot unite once fractured, and a fragment that has moved once can always move again.

The history in cases of nuclear herniation is equally characteristic. The patient carried on some heavy work involving much stooping and lifting, *e.g.* laying a concrete path. After some hours he felt a slight backache but thought little of it.

That evening, after sitting for an hour or two in his armchair he found that severe lumbar pain prevented his rising to his feet. He struggled to bed and slept comfortably, next morning, he found the slightest movement so painful that he was forced to stay where he was He lay in bed for a week or two and then recovered. Sooner or later, he had another attack. This account describes the onset of a displacement slowly increasing in size, i.e a pulpy protrusion Pulp oozes cartilage subluxates in an instant. The distinction has an important bearing both on treatment and on the maintenance of reduction. A patient with a pulpy lesion can, for example safely play tennis again for, though he bends down, he comes up again instantly and the prolonged flexion that sets up nuclear movement does not come into operation. On the other hand, a patient with a cracked annulus has to be constantly on his guard

A patient who declares that his lumbar pain was central or bilateral at first but is now unilateral must have a disc lesion His statement indicates that the lesion has moved from the centre of the back to one side In order to move in this way the lesion must occupy a central cavity and there is only one such, the intervertebral joint. The converse does not hold, for a patient with either a disc-lesion or spondylitis deformans may describe unilateral pain later becoming central. But sacro-iliac involvement never comes on after the lumbar spine has become affected. The history most typical of spondylitis deformans is alternating pain in the buttocks, when it appears on one side it leaves the other Occasionally there is bilateral pain for a few days at the change-over, and referred pain in the posterior thigh and calf is common Rather a similar story is recounted by patients with two low lumbar disc-lesions, i.e at both the fourth and fifth levels.

In very early disc lesions, or in those that remain minor, the characteristic feature is aching dependent on how much the patient exerts his back. Any work involving stooping occasions sudden twinges or is followed by pain if he takes things quietly he feels little or nothing He may experience difficulty in straightening up after bending or in getting up out of an armchair (i.e after keeping his back bent has allowed some posterior displacement of part of the disc)

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Turning in bed is often mentioned as occasioning a t
awakening him. A rare symptom is a momentary pa
giving way of both legs. The following curious sequence
be described. For the first few years after backache beg
was absent in the morning and brought on by exertion ;
it changed and now the patient feels such aching and sti
on waking in the morning that he is glad to get out of
moving about soon relieves the pain. The back may
again in the afternoon and evening. Rarely, a small
lesion sets up nocturnal or matutinal pain only.

A different account designates a self-reducing disc-l
The patient wakes comfortable. If he stands, pain con
regularly in, say, fifteen minutes and soon becomes so s
that he has to sit or lie down again. As soon as he
the pain disappears This sequence is also describ
spondylolisthesis, with or without a secondary disc-
(see p. 428) It also characterizes the mushroom p
menon resulting from anterior protrusion of disc-subs
(see p 420).

Pain on coughing suggests, but is not pathognomonic
disc-lesion. Curiously enough, patients with sacro-iliac
ritis of any severity all state that coughing hurts i
buttock. A cough also hurts a patient with acute in
ment of a costo-vertebral joint, again in the course of sp
litis deformans. An intraspinal lumbar neuroma resu
pain on coughing felt in the lower limb.

Backache that comes and goes independently of ex
suggests spondylolisthesis or spondylitis deformans.]
ache getting inexorably worse for months suggests ch
osteomyelitis.

Lumbago without Disc-lesion. There are three rare c
tions in which a history of lumbago is described an
internal derangement is not the cause—fracture, spond
deformans and tabes. A patient with malignant disease
lumbar vertebra, senile osteoporosis or, yet more rarel
predisposing lumbar disorder, may describe sudden lu
pain on lifting an object followed by difficulty in straight
up again. Though the history is similar, one glance a
lumbar spine shows the angular kyphos. Again, a pa
with spondylitis deformans affecting the lumbar spine
painfully and repeatedly sprain the ankylosing lumbar j

by heavy lifting The attacks simulate lumbago but the pain may be *upper* lumbar and in any case, by the time these events are described, the range of both side-flexions at the lumbar spine is visibly impaired. Hence the diagnosis becomes obvious as soon as the lumbar movements are watched Lumbago is occasionally mimicked by tabes. Cases occur of lumbar crises instead of gastric crises The patient suffers periodic attacks of severe lumbar pain without vomiting for which, on examination, no lumbar lesion is found to account Absence of the tendon reflexes at the lower limbs naturally leads to examination of the reaction of the eyes to light and to the serological tests for syphilis

ROOT PAIN

In severe lumbago, the pain may spread upwards towards the lower thorax, round to the lower abdomen into the groin (occasionally reaching the scrotum or perineum), down the front, back or outer sides of both thighs These are examples of misleading dural reference and have no localizing value On the other hand pain felt to radiate down *one* lower limb accurately outlines the affected dermatome. Lumbar pain felt to radiate down the front of the thigh to the knee designates a lesion at the second or third levels, if the pain runs down the front or inner aspect of the leg to just above the ankle the third lumbar dermatome is accurately outlined The fourth and fifth dermatomes start at the outer side of the mid thigh and extend down the outer leg to the big toe, crossing over at the dorsum of the foot. The first sacral dermatome occupies the calf, and ends at a variable number of the little toes Sometimes only the fifth toe is analgesic, sometimes the outer two or three or four It should be noted that in fourth and fifth lumbar and first sacral root pressure the pain defies anatomical knowledge and is felt in the buttock (first lumbar dermatome) and the upper thigh —areas not included in the relevant dermatomes.

Patients usually state that, when the pain in the limb comes on, the lumbar symptoms abate. This is most reasonable for when a displacement passes towards one side or other of the posterior longitudinal ligament to impinge on the nerve-root, it ceases to lie centrally where it exerted pressure on

the dura mater. This sequence is seldom described by elderly patients, who by contrast often say that the backache and root-pain come and go together.

Primary postero-lateral protrusions usually come on slowly, and never impinge on the dura mater at all; hence premonitory backache is absent. The patient describes a pain coming on gradually at the calf, at the back of the knee or at the posterior aspect of the thigh. After some weeks or months the whole posterior aspect of one lower limb is affected; the pain may extend to the buttock in the end. A cough hurts the thigh. This history is important, for such protrusions are always irreducible by manipulation.

Bilateral sciatica, especially if it alternates, suggests the sacro-iliac arthritis of spondylitis deformans, less often it designates disc-lesions at both the fourth and fifth lumbar levels. Rarely a fragment of disc may cross the mid-line and give rise to root-pressure at the other side of the joint. Bilateral sciatica without alternation characterizes spondylolisthesis, the mushroom phenomenon and malignant disease. Pain of similar distribution is described in bilateral osteoarthritis of the hip, intermittent claudication and tabes.

PARÆSTHESIÆ IN THE LOWER LIMB

These are a common accompaniment of root-pain, especially when a protrusion compresses the superior aspect where the sensory fibres run. Pins and needles in one or both lower limbs also result from pressure on the spinal cord from space-occupying lesions at any cervical or thoracic level, usually central disc-protrusions. It is important to remember that such central protrusions may give rise to neither local pain (then or previously) nor to any interference with the mobility at the relevant joint. For example, a doctor who had had a spastic paresis of both legs for seventeen years had never had any neckache. He had a full and painless range of movement at his neck and yet myelography revealed a very large disc-protrusion at the sixth cervical level, which was removed. Sometimes a clear sign emerges; one patient complained of pins and needles in his big toe on bending his head forwards; this was abolished by manipulative reduction carried out at his neck. In other cases, suspicion is aroused by the fact that

the paræsthesiæ are bilateral and neither spondylolisthesis nor the mushroom phenomenon are present. Alternatively, they may occupy an area not corresponding to any root or peripheral nerve area. For example, an elderly man whose cervical disc displacement was reduced with difficulty had had neckache for ten years and one year's paræsthesiæ extending from the patellæ to the toes of each foot—an impossible anatomical distribution. Another patient whose mid thoracic disc-protusion responded to traction had had eighteen months' pins and needles at the inner three toes of one foot and the same at the other foot for three months.

Hence pins and needles felt in one or both lower limbs without root pain focuses attention on the cervical and thoracic spine, not the lumbar spine, if local investigation reveals no abnormality.

Lesions causing paræsthesiæ in one lower limb are

Front of thigh: second or third lumbar nerve-root; friction on lateral cutaneous nerve.
Front of leg: third lumbar nerve-root.
Outer leg: fourth or fifth lumbar nerve-root.
Big toe: fourth or fifth lumbar nerve root.
Big and second toe: fifth lumbar root, tight fascial compartment, pressure on second digital nerve.
Big and two adjacent toes: fifth lumbar root.
All toes: compression of peroneal nerve at fibula, combined pressure on fifth lumbar and first sacral root.
Second toe and sole: loose body in knee.
Second, third and fourth toes: first sacral root, Morton's metatarsalgia.
Heel, calf and posterior thigh: first and second sacral roots.
Saddle-area: fourth sacral root.

Lesions causing paræsthesiæ in both lower limbs are

Spondylolisthesis
The mushroom phenomenon
Cervico-thoracic disc-lesions protruding centrally
Vertebral neoplasm
Tabes

EXAMINATION

Nothing is easier than to decide that the patient has a disc-lesion. But it is by no means enough to say "another disc." This bare statement lacks all the detail essential to the formulation of an accurate prognosis and the prescription of proper treatment. Many relevant questions must first be answered: is it large or small; is it in place or out of place; is it cartilaginous or pulpy or both; in which direction has it moved; at which level does it lie; is it movable or fixed; is it likely to get larger or to recede; is it dangerously placed; is it causing severe pain, gross deformity or not; is it interfering with a nerve-root and, if so, is the limitation of movement and/or the palsy important or not; is bone erosion or pressure atrophy taking place and, if so, when did it begin; have adhesions formed about the root?

Although the shift from postero-central to postero-lateral is a slight one anatomically, patients' signs vary in emphasis according to this change in position of the protrusion. In the former case, articular signs predominate. When pain felt in the limb supervenes the articular signs diminish and may disappear; it is then that the root signs become obvious. This happy alternation makes for ease in diagnosis.

INSPECTION

The patient's gait should be noted as he enters the room together with the way he moves to sit down and the position in which he prefers to sit. These important diagnostic points are lost if the patient is first seen lying in bed at home or in hospital; their absence puts the physician at a real disadvantage. The examiner should also scrutinize his face, to assess how badly the pain is affecting him constitutionally. The peaky faces and sunken eyes of spondylitis deformans may be seen. However, occasional spondylitic patients are fat and cheerful, so too much reliance should not be placed on appearances in this disease.

The patient stands with the whole posterior aspect of the body bared from head to feet. The light should fall from a source behind him, so that unilateral shadows do not give a false idea of the shape of his trunk. The examiner notes:

1 *The Position of the Pelvis*

Is it horizontal or oblique ? If it is oblique, the legs are not the same length or fixed deformity exists at the hip In the latter case, one heel is off the ground Boards should be placed under the foot of the shorter limb until the pelvis becomes horizontal. If a lumbar lateral deviation disappears when the pelvis is thus made level, it is the result of the pelvic obliquity If it remains, the deformity is intrinsically lumbar The patient should be asked what the effect is on his pain when the shortening is compensated for Sometimes a lumbar pain can be abolished thus if so the treatment is obvious

2 *The Shape of the Lumbo-thoracic Spine*

Is there an angular kyphos ? If so, a vertebral body has become wedge-shaped, as the result of tuberculous caries, neoplasm, fracture, localized osteitis deformans, or senile osteoporosis alternatively gross thinning of two adjacent discs gives rise to this appearance Does the patient stand upright or is he bent forwards at lumbar spine and hips ? This flexed posture is typical of acute lumbago but is also seen in advanced spondylitis deformans

Does he stand evenly on both legs ? In sciatic root pain due to a disc lesion or neoplasm of the ilium, the patient may be unable to put the foot on the painful side flat on the floor and stands with all his weight on the painless limb using the other foot on tip-toe.

Is the back unduly flat ? If so is the thoracic kyphosis greater or less than usual ? If it is less (i e the lumbo-thoracic column forms a vertical line) the cause is a failure in development, the infantile flatness of the lumbar spine persisting into adult life. This posture leads to a graceful carriage but an enhanced likelihood of disc protrusion. If the thoracic kyphosis is exaggerated, spondylitis deformans or adolescent osteochondritis should be suspected in the young osteitis deformans or senile osteoporosis in the elderly

Is there an excessive lordosis ? If this is compensated for by an equally excessive thoracic kyphosis, the deformity dates from adolescence and is termed postural If there is

osteitis deformans, senile osteoporosis or advanced degeneration of the discs leading to diminished joint spaces at all the lumbar joints.

The recent development of genu varum in an elderly patient suggests osteitis deformans.

SPINAL MOVEMENTS

The patient stands and four movements are investigated: extension, two side-flexions and flexion. Range is watched; painfulness enquired after. Since flexion is the movement that most often hurts, it is performed last, lest a persisting ache after this movement should obscure the responses to the other movements.

Since lumbago and sciatica are variants of the same disorder, the signs are interchangeable. Occasional patients with sciatica are found who adopt the flexed posture of lumbago (see Plate 23) and in most of these the pain in the limb is set up on trunk-extension; trunk-flexion and, later, straight-leg raising prove painless. By contrast, patients with unilateral lumbar pain only may show the lumbar deviation, limitation of trunk-flexion and of straight-leg raising on one side that are more typical of sciatica.

Extension

This may be limited or of full range, painful or painless. In acute lumbago extension is lost altogether on account of the block at the back of the joint. In minor degrees of backache, extension is often painful at full range. Quite a common pattern in unilateral backache is: extension hurts centrally but full flexion hurts at one side of the back. Limitation of extension with pain occurs in serious disease of the spine, including spondylitis deformans. Painless limitation of extension characterizes osteophyte formation. If a disc-lesion and osteophyte formation co-exist, extension is limited and may prove painful.

Side-flexion

All serious diseases of the lumbar spine result in limitation of the range of both side-flexion movements. Rather a practised

eye is required, since the range of this movement diminishes with the patient's age. Hence knowledge of what range that particular individual ought to possess must be correlated with that actually found present.

Tuberculosis, malignant and benign neoplasm, chronic osteomyelitis, severe fractures and spondylitis deformans all give rise to marked painful limitation of these two movements. Painless limitation of side-flexion in an elderly patient denotes osteophyte formation. Limitation of side-flexion in one direction only is usually associated with a visible lateral deviation when the patient stands; it signifies a block lying at one side only of one joint—in other words, a lumbar disc lesion, usually at the fourth level.

One or both side-flexion movements may hurt. If each hurts on the side towards which the patient bends, he is clearly squeezing something painfully This can result only from a lesion placed intra articularly for all the other structures on that side of the lumbar region are relaxed in this position. If it hurts on the side away from which he bends, he is stretching both joint and muscle, then, as elsewhere, it is the discovery later that the resisted movement in the opposite direction is painless that incriminates the joint. Alternatively, if extension and side-flexion away from the painful side both hurt, the symptoms must arise from the joint since full extension relaxes the sacrospinalis muscle. If side-flexion hurts only on the side towards which the patient bends, experience has taught me that success from an attempt at manipulative reduction is very problematical. If two or more of the lumbar movements hurt in the lower limb instead of at the lumbar region or upper buttock, manipulation likewise nearly always fails

A *painful arc* may be felt on side-flexion. It takes two forms. The early part of the movement hurts, but at full range the pain has ceased Alternatively the patient may complain of pain as his trunk passes the vertical on swinging from side to side. A painful arc is pathognomonic of a disc lesion for it shows that the bone rides over an intra articular projection during movement.

Flexion

Patients with any serious disease of the lumbar spine flex from the hips, the lumbar spine being fixed in lordosis by spasm of the sacrospinalis muscles. This sign accompanies limitation of side-flexion (see above). An occasional case of lumbago gives this sign, and must not be attributed to a disc-lesion until radiography has demonstrated no other disorder to be present. A limited range of flexion means that the patient is prevented from stretching the dura mater or a sciatic nerve-root Thus in central lumbago, pain limits standing trunk-flexion and, by corollary, straight-leg raising is later also found bilaterally limited. Neck-flexion often hurts in the lumbar region too, since this is another way of stretching the dura mater. In unilateral pain, whether in the lower back or the limb, the patient, though he stands upright symmetrically, may be found on flexion to deviate towards or away from the painful side, according to which side of the nerve-root the protrusion has passed (see p. 400). Limitation of trunk-flexion because of pain felt in one thigh and/or calf shows that the patient cannot stretch his sciatic nerve-root beyond a certain point. Usually this is associated with pain felt in the lower lumbar region or upper buttock on one or two of the other movements of the lumbar spine. However, usually in primary postero-lateral protrusion, limitation of trunk-flexion may prove the only sign, the other three lumbar movements being found of full range and painless. In such a case the change from articular signs to the root signs is seen at its clearest.

Pain appearing when full flexion is reached merely implies that some structure is painfully stretched or moved. In a disc-lesion, the mechanism is twofold. First, the dura mater lies stretched against the back of the intervertebral joint at full trunk-flexion; it may be applied more forcibly to any projection present by this movement. Secondly, when the intervertebral joint is held in kyphosis, its contents tend to be squeezed backwards; hence the projection may increase in size. For this double reason, full flexion usually hurts in lumbar disc-lesions as well as in other spinal disorders.

Painful Arc. This may be felt and seen on trunk-flexion. It shows itself in two ways. The patient may state that as

he reaches the half way-down position a momentary lumbar pain is felt. If this is not felt on the way down, it should be looked for on the way up from trunk flexion, for this brings the sign out best. Alternatively the patient may be seen suddenly to deviate laterally at half flexion, returning to a symmetrical posture as soon as this point has passed He is quite unaware of this momentary deviation. Usually pain is felt at the arc, occasionally it is visibly present but devoid of pain A painful arc is usually associated with pain at the extreme of one or other of the lumbar movements, but it can be an isolated finding

A painful arc means that a fragment of disc lies loose in the joint and alters its position when the tilt of the articular surfaces reverses itself as the lumbar spine passes from lordosis to kyphosis The pain, but not the visible deviation as the patient bends, is abolished by epidural local anaesthesia hence, the mechanism must be a jarring of the dura mater via the posterior ligament as the fragment alters its position A painless arc implies that the articular surfaces deviate to ride over a projection within the joint, but the loose piece does not project enough to interfere with the dura mater

Patients with a painful arc can sometimes produce a palpable and audible click, often painless on trunk movements They can also induce the arc by tilting their pelvis to and fro on their lumbar spine rather than by flexing the spine on the pelvis, it is merely another way of doing the same thing

A painful arc, whether on flexion or less often on side-flexion is extremely helpful in diagnosis It is pathognomonic of a disc-lesion and is present in just those early cases in young persons at a time when no other distinctive sign is revealed by examination.

Neck flexion. In some cases of fairly severe lumbago, flexing the neck may hurt in the lumbar region Rarely, this is the last movement to become painless during recovery It might be argued that neck flexion stretches the sacrospinalis muscles as much as it stretches the dura mater This is true but if resisted extension at the neck is tested this proves painless, thus exculpating the muscle.

The Pattern There is unfortunately no one pattern distinctive of a disc lesion when the lumbar movements are

performed. Depending on the size and situation of the protrusion—not to mention whether there are one or two—different patterns are found, all nevertheless indicating the presence of an intra-articular displacement.

The expected pattern would obviously be one showing that part, but not the whole, of the intervertebral joint was affected—two or three, but not all four, lumbar movements hurting at their extreme. The range of movement should be limited in only one or two directions. Such patterns are commonly encountered. However, in severe lumbago all four movements may be painful and limited in range. In minor backache, a painful arc may be the only finding, each extreme of range proving pain-free. If a patient is examined for a suspected disc-lesion at a time when no displacement is present, or in the uncommon event of purely nocturnal pain, nothing is found. He must be seen at a time when the discomfort is present.

THE PATIENT LIES SUPINE

The sacro-iliac joints are tested by pressure on both anterior superior spines of the ilium (see p. 496). The range of flexion, rotation and, if necessary, abduction and adduction at the hip-joints is ascertained (see p. 519); the resisted hip movements may require testing for pain or weakness (see p. 520). One advantage of testing these movements is that they none of them hurt appreciably in patients with disc-lesions (except acute lumbago). It is true that full hip-flexion both flexes the lumbar spine and pulls slightly on the sciatic nerve-roots; it therefore often hurts a little. Rotation at the hip is certainly of full range but may set up discomfort at one extreme in an occasional case of sciatica, for no apparent reason. The resisted movements do not hurt.

Straight-leg Raising

Straight-leg raising tests the mobility of the sheath of the fourth and fifth lumbar and first sacral nerve-roots. In normal individuals it varies from 60° to 120°, and at the extreme an uncomfortable stretching is always felt at the back of the knee.

The range of straight leg raising is first estimated on the painless side In disc lesions, at the extreme of range pain is sometimes felt in the other thigh or buttock on account of transmitted tension via the dura mater especially if the protrusion lies between dura mater and nerve-root at the fourth level The range on the painful side is noted next. This is nearly always limited in pressure on those roots whose trunk passes behind the hip-joint (i.e the fourth and fifth lumbar and the first sacral)

When the straight limb has been raised to the point where pain just begins the patient is asked to flex his neck, keeping his trunk still. This often increases the pain by pulling on the other end of the nerve-root via the dura. It is a useful test, proving that the tissue in which the pain originates runs from the neck to below the knee, passing behind the hip joint.

Straight leg raising is limited in meningeal irritation from any cause, and is known as Kernig's sign This merely elicits limitation of straight leg raising in a different way by showing that the knee has to flex when the trunk is flexed on the thigh The causes of limitation of straight leg raising other than disc-lesion are: any other intraspinal lesion, e g tumour, at or below the fourth level, malignant disease or osteomyelitis of the ilium or upper femur fractured sacrum, ischio-rectal abscess, hæmatoma in the hamstring muscles In all the above conditions affecting the buttock, hip flexion is limited too hence "the sign for the buttock" —limitation of straight leg raising and of hip-flexion— emerges and the physician is put on his guard at once (see Chapter XIX)

The cause of limitation of straight leg raising is spasm of the hamstrings it is an involuntary protective mechanism preserving the intraspinal roots from painful traction analogous to the muscular spasm set up by appendicitis or arthritis One has only to realize this useful purpose to shudder at the days (not so far in the past) when straight leg raising was forced under anæsthesia with lamentable results

In some cases of central lumbago and an occasional case of unilateral sciatica, straight leg raising is limited on both sides This is easy to understand in lumbago when the protrusion lies centrally and the dura mater resents a pull from either side In sciatica, bilateral limitation of straight

leg raising characterizes a protrusion lying at the axilla of the fourth nerve-root. When the dura mater is pulled towards the painless side, the nerve-root is drawn against the protrusion lying at its medial aspect. Thus the mechanism for limiting straight-leg raising is brought into play. Long-standing backache, accompanied by marked bilateral limitation of straight-leg raising, affects patients chiefly between the ages of eighteen and thirty. It can go on indefinitely without altering and is usually caused by a central pulpy protrusion at the fourth lumbar level (see p. 157). There is more room at the fifth joint and this phenomenon is very seldom encountered. Straight-leg raising does not pull on the third lumbar root, of course; it relaxes it. Nevertheless this movement is often painful (usually in the buttock) at full range in third lumbar root-pressure on account of transmitted dural pull. The same phenomenon accounts for the rare increase in local discomfort during full straight-leg raising in a lowest thoracic disc-lesion.

A *painful arc* may occur on straight-leg raising, usually at 45°, movement above and below this point proving painless (see Fig 68). This must imply that the nerve-root catches against a small protrusion and slips over it. It is quite a common phenomenon when a patient is nearly well in the course of reduction by sustained traction of a pulpy postero-lateral herniation.

Straight-leg raising is the test for the sheath of the sciatic nerve-roots. If the fourth or fifth lumbar or first sacral root is affected at its intraspinal course, limitation of straight-leg raising nearly always results. This movement is often unilaterally limited in cases of sciatica showing no parenchymatous signs.. This combination indicates that the mobility of the nerve-sheath is impaired, but that conduction is unaffected; in other words, the protrusion is not very large. Except in root-atrophy, the range of straight-leg raising is inversely proportional to the size of the protrusion. For example, during successful manipulative reduction, it increases from moment to moment as the displacement recedes. Hence, though the root may have suffered pressure for several months—and might on that account have been thought likely to stay bruised for some time afterwards—it reaches full range the instant reduction is complete. The

range of straight leg raising is thus a reliable and delicate test of what is taking place at the nerve-sheath, and by inference at the joint.

The range of straight leg raising is unconnected with the degree of parenchymatous involvement for it indicates merely the degree of mobility of the external aspect of the root sheath. To start with, impaired conduction and limitation of straight leg raising go together beyond a critical point they go opposite ways. If a large protrusion presses hard enough to deprive the nerve-root of percipience (presumably from local ischæmia) straight leg raising becomes of full range and painless at the same time as the root palsy becomes complete.

If the range of straight leg raising is restricted, so must the range of trunk flexion be equally restricted, and inconsistency in this direction indicates psychogenic pain. However, the converse does not hold. During standing the affected joint is compressed the protrusion may thus be slightly larger then than while the patient is lying down. Hence limitation of trunk flexion may genuinely co-exist with full (but usually not painless) straight leg raising Inconsistency in this direction must not be regarded, therefore, as suggesting psychogenic pain, in spite of Aird's (1956) view

The fact that straight leg raising is of full range often indicates the time when a patient with sciatica treated by rest in bed should get up This does not apply to patients undergoing spontaneous recovery by erosion of the vertebral body (see p 309), who can get up as soon as their pain on doing so becomes tolerable

The three stages of straight leg raising To sum up, a small postero-lateral protrusion interferes with the mobility of the nerve-root at the intervertebral foramen but does not affect conduction Hence in this first stage, straight leg raising is limited and there are no neurological signs In the second stage the protrusion is larger hence straight leg raising is further limited and conduction becomes impaired. In the third stage, the protrusion is larger still and insensitivity of the sheath of the nerve-root restores full and painless straight leg raising when the root palsy has become complete.

Tests for Conduction

The examiner must test conduction conscientiously not only for diagnosis' sake, but in order to be able to arrive at a proper choice of treatment. He must add up in his mind as he goes along the magnitude of parenchymatous involvement. The greater the degree of interference with conduction, the greater the force compressing the nerve-root; in other words, the larger the protrusion. The rule may be safely followed that two or more signs of interference with conduction (*e g.* a sluggish ankle-jerk and a weak muscle) mean that an attempt at manipulation will fail. By contrast, limitation of straight-leg raising with normal conduction is a most encouraging sign in this connexion.

It is unusual to find all the possible signs of a root-palsy in any one case. For example, if cutaneous analgesia is present, the muscles are often strong. If the muscles are weak, the ankle-jerk may remain brisk, and so on. Though cases are, of course, encountered showing every possible sign, these are exceptions It would seem that if one aspect of the root receives the greatest impact, the fibres on either side escape. Hence only partial signs are to be expected.

A disc-lesion affects, in general, only one nerve-root. Hence an essential part of the examination is to show that roots on either side are unaffected. For example, if the fourth lumbar root is compressed, the examination is not complete until the third and fifth roots have been shown to conduct normally. Involvement of several roots suggests a spinal neoplasm, not a disc-lesion. However, owing to the obliquity of the fourth and fifth lumbar and first sacral roots, two can be compressed by one large protrusion (see p 385)

Resisted Movements. Resisted flexion of the hip is tested. It is weak in second or third root-palsy. If contraction of the psoas muscle is weak and painful, the physician must remember that he is testing part of the posterior abdominal wall and that neoplasm here, or at the upper lumbar spine itself, is the usual cause of this sign. Weakness, even without pain, of the psoas muscle is hardly ever caused by a disc-lesion except as a minor part of a third root-palsy. If, then, this muscle is weak alone, serious disease at the upper lumbar levels must be suspected.

The muscles controlling the foot are examined next. The tibialis anterior is tested by asking the patient to dorsiflex his foot strongly The examiner must put all his power into resisting this movement minor weakness otherwise goes unperceived, since the normal individual's strength far surpasses the examiner s The tibialis anterior muscle is derived largely from the fourth lumbar segment and is rarely found appreciably weakened in a third or fifth lumbar palsy The extensor hallucis is tested next, the examiner is stronger than the patient this time. It forms part of the fourth and fifth lumbar myotomes Thus though weakness of this muscle is important as showing that the protrusion is big enough to have resulted in muscle weakness it does not help to indicate which root. Eversion of the foot tests the peroneal muscles these are stronger than the examiner s resistance They are supplied by the fifth lumbar and first sacral nerve-roots hence weakness indicates a lesion here If, therefore, a disc lesion is present, it lies at the fifth level.

Analgesia. Search is made for cutaneous analgesia If the third lumbar root is involved, this is found just above the front of the knee, at the inner side of the knee or down the front and inner side of the leg to just above the ankle In fourth or fifth lumbar root palsy the big toe is often analgesic. When the first sacral root is affected, sensitivity of the skin may be impaired at the outer border of the foot and/or the outer one, two or three toes

The knee-jerk is sluggish or absent in third lumbar root lesions

Arterial Examination

Pulsation should be felt for at the dorsalis pedis and posterior tibial arteries if intermittent claudication is suspected. Pitting œdema of one foot suggests venous thrombosis or angioneurotic œdema unless it is accompanied by gross neurological signs in which case it usually indicates malignant disease in the pelvis Inflamed varices at the ankle, empty and invisible when the patient lies, may cause local heat if this is found the ankle should be examined again while the patient stands In thrombosis of the external iliac artery, the affected leg and foot are cold for many hours after

exertion; after a day or two's rest in bed this difference on the two sides disappears. The tibia may be warm in osteitis deformans. Secondary deposits at the second lumbar level affect the sympathetic supply and give rise to a warm foot.

THE PATIENT LIES PRONE

The calves are inspected anew. Wasting may be visible in first sacral palsy. Weakness of a calf muscle is seldom

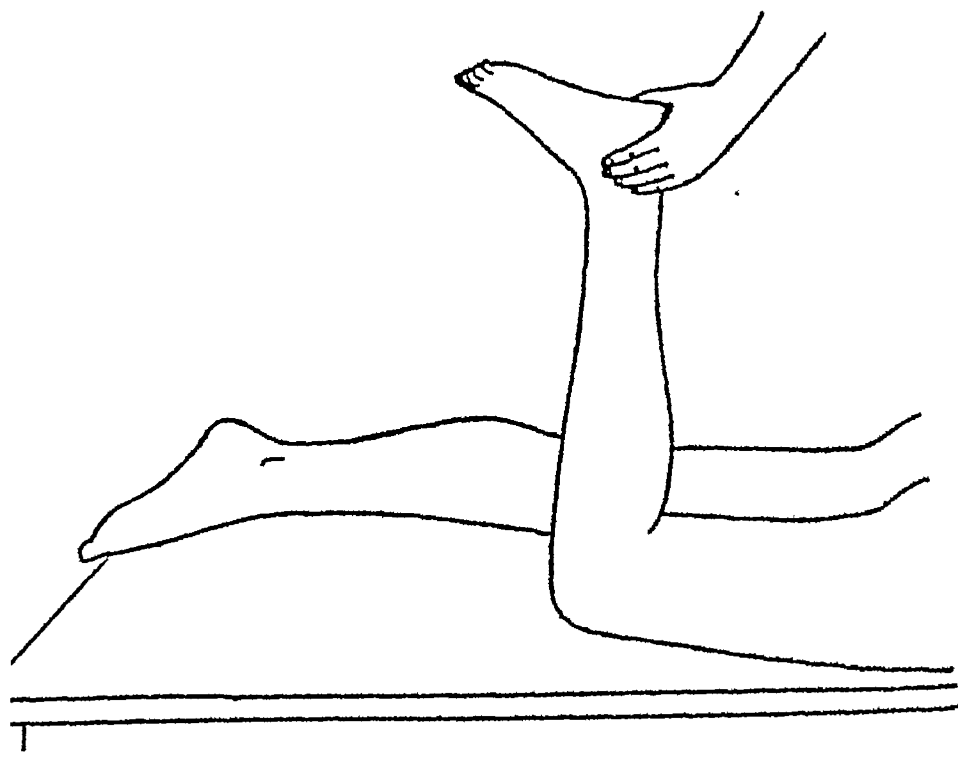


FIG. 60—Resisted flexion of knee The examiner resists the movement pressing against the patient's heel.

detectable on trial of plantiflexion against resistance, but can be demonstrated by asking the patient to stand tip toe first on the painless leg then on the painful one.

The ankle-jerk is tested next. It becomes ... sluggish or absent in fifth lumbar and first sacral ... Once having disappeared, it may never return ... patient has completely recovered. Hence ... sciatica, its absence implies that the patient ... palsy once, but not necessarily that any prot... now. Bilateral absence of the ank... ars

sional case of unilateral sciatica and may also develop after the mushroom phenomenon has been established for some months, in spondylolisthesis, tabes and malignant disease.

Weakness of the quadriceps muscle is best tested with the patient prone the two sides are compared The patient should be stronger than the examiner In a third lumbar root palsy the quadriceps is weakened in severe cases in conjunction with the psoas muscle Weakness accompanied by increased pain indicates a partial rupture of the quadriceps or a fractured patella

The state of the hamstring muscles is best demonstrated by asking the patient to flex his knee against resistance (see Fig 69) this time the examiner is stronger than the patient. Weakness of the hamstrings shows that, if a disc-protrusion is responsible, the first sacral root is compressed, i.e that the lesion lies at the fifth lumbar level

Weakness of the buttock muscles is seldom demonstrable, but wasting is often visible. It is best noted at the outer aspect of the gluteal mass when the trunk is viewed horizontally When he is asked to contract his buttock muscles, the muscles on the normal side stand out prominently, those on the affected side remain flat and can be felt to remain very podgy on palpation Increase in the size of the affected buttock is found in sarcoma of the ilium or a cold abscess originating from the sacro-iliac joint.

Prone-lying Knee flexion

This is the test for the sheath of the third lumbar nerve-root (see Fig 70)

When a patient lies supine, flexion at the knee involves flexing the hip too hence the quadriceps muscle and femoral nerve are relaxed above in proportion as they are pulled on from below However, when a patient lies prone, the hip does not move as the knee flexes and the constant length phenomenon comes into play Limitation of prone lying knee-flexion thus indicates a lesion connected with the anterior aspect of the thigh If the quadriceps is neither abnormally adherent to the shaft of the femur (*e g* after fracture of the femoral shaft) nor painful on resisted contraction, the muscle is exculpated and the limiting factor

exertion; after a day or two's rest in bed this difference on the two sides disappears. The tibia may be warm in osteitis deformans. Secondary deposits at the second lumbar level affect the sympathetic supply and give rise to a warm foot.

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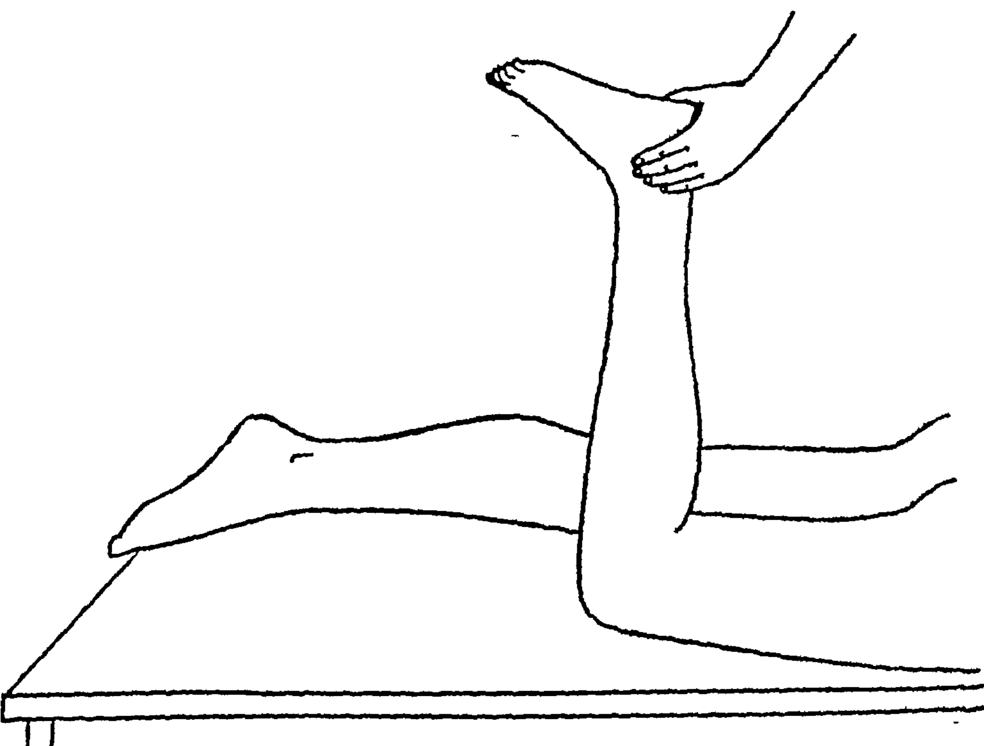


FIG. 69—Resisted flexion of knee The examiner resists the movement pressing against the patient's heel

detectable on trial of plantiflexion against resistance, but can be demonstrated by asking the patient to stand tip-toe first on the painless leg then on the painful one.

The ankle-jerk is tested next It becomes unilaterally sluggish or absent in fifth lumbar and first sacral root-palsy. Once having disappeared, it may never return even when the patient has completely recovered. Hence in recurrent sciatica, its absence implies that the patient had a root-palsy once, but not necessarily that any protrusion exists now. Bilateral absence of the ankle-jerk occurs in an occa-

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must be the nerve and not the muscle. In fact, prone-lying knee-flexion is to the third root what straight-leg raising is to the three roots below. Unfortunately it is a far less constant sign than straight-leg raising. In most third-root lesions

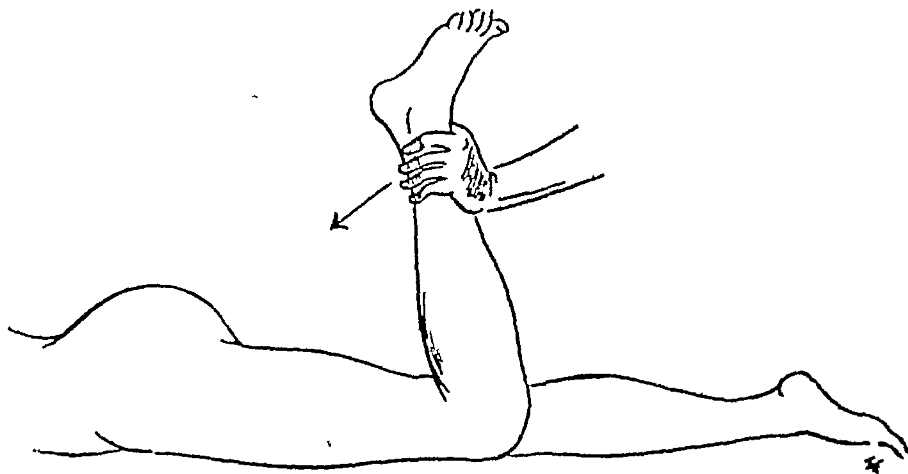


FIG. 70.—Test for the third lumbar nerve-root. The patient lies prone, so that the hip remains extended. As the knee is flexed the third lumbar nerve-root is stretched via the femoral nerve. In disc-protrusion at the third lumbar level flexion at the knee is unilaterally painful at its extreme, occasionally limited in range. Exceptionally, when a protrusion lies at *the axilla of the root, full flexion of the knee on the painless side hurts* the thigh on the affected side.

it is full and painful rather than limited. Since the extreme of this movement is uncomfortable in any individual, the question involves degrees of painfulness; a very much less satisfactory criterion than visible limitation of movement.

If it is limited, the amount of movement obtainable varies according to the size of the protrusion (except in root-atrophy) in the same way as does straight-leg raising, and provides the same useful criterion during attempted reduction.

Palpation

The lumbar spine is palpated for any irregularity of the spinous processes. The physician should run his hand quickly down the central furrow of the spine and feel for any projection that arrests the progress of his fingers. Unfortunately congenital shortening or lengthening of one spinous process leads to unfounded suspicions.

An angular kyphos indicates wedging of a vertebral body;

a shelf indicates spondylolisthesis In concealed spondylolisthesis the irregularity is visible and palpable as the patient stands, but can *no longer* be felt when the patient lies down (see p 420) If an irregularity can be felt giving rise to acute lateral angulation of the spine, hemivertebra or asymmetrical erosion of bone in the course of tuberculous caries should be suspected

As in all disorders affecting bone, radiography is essential.

The Resisted Lumbar Movements

These should be tested if three possibilities have arisen (1) *Was there direct unilateral trauma to the lumbar spine?* If so the last rib or one or more transverse processes may

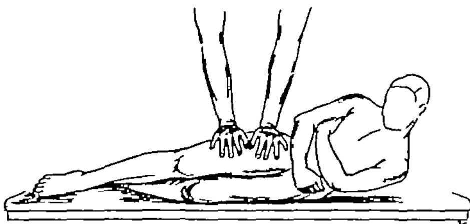


FIG. 71.—Test for the sacrospinalis muscle. The patient lies on his painless side, his thigh supported by the examiner He crosses his arms in front of him and lifts his thorax off the couch without using his elbow This puts a strong strain on one sacrospinalis muscle. This movement is found painful in fracture of a transverse process.

have been injured These minor fractures show themselves as muscle-lesions, giving rise to pain on resisted contraction of the sacrospinalis muscle. (2) *Is the patient suspected of psychogenic symptoms?* If so a comparison of the effect of active, passive and resisted movements may prove informative. (3) *Does the examiner believe in fibrositis?* Then he must test the muscles separately from the joints to identify the tissue affected Had such obvious tests for independent function been universally adopted, ' fibrositis " and its variants would have died a natural death long ago

The tests for the sacrospinalis muscles are two: prone-lying trunk-extension and side-lying trunk-side-flexion. First, the patient lies prone and the examiner resists extension by placing one hand at the backs of the knees, the other at the upper thorax posteriorly The response to this movement may be profitably compared with that to passive extension. The patient lifts his thorax off the couch by extension at the elbows, letting his body sag Passive extension of the lumbar spine results. Then the patient turns to lie on one side, crosses his arms in front of his chest and, without using his elbow, lifts his thorax off the couch The physician steadies his thighs during the movement (see Fig. 71).

If the resisted movements show that one or more transverse processes have probably been fractured, palpation helps to identify the level. Radiography is clearer still, and shows exactly where local anæsthesia should be induced in treatment.

One difficulty in interpretation may arise. As was set out in the previous chapter, the first effect of a contraction of the sacrospinalis muscles is to compress the lumbar joints. Hence, resisted extension may hurt even in a disc-lesion However, passive extension relaxes the muscles while straining the joint; hence it is only the combination of resisted extension hurting with passive extension not hurting that directs attention to the muscle. The same applies to side-flexion.

Forcing Extension

If nothing has emerged during examination of the trunk or lower limbs to show at what level a disc-lesion lies, a final attempt may be made by forcing extension. As the patient lies prone a series of pressures towards extension is given, starting at the sacrum and then repeated at each lumbar joint. The patient is asked to state at which level the forcing provokes the greatest discomfort.

DIAGNOSTIC LOCAL ANÆSTHESIA

Sometimes the pattern obtained on examination shows merely that the symptoms arise from the moving parts of the back, but whether from a disc-lesion or not is uncertain.

In these cases the induction of epidural local anæsthesia diagnostically should be carried out at once (see p 459) The solution is confined within the neural canal by bone and ligament, it can escape only by the intervertebral foramina Hence it anæsthetizes the dura mater and its investment of each nerve-root it cannot reach the muscles or pass intra articularly (see Plate 25) If then the symptoms arise from indirect pressure on the dura mater because of minor displace ment of a fragment of disc, pain ceases for the duration of local anæsthesia. If not, not. If this simple means of confirming or disproving a diagnosis of an early disc lesion were more universally applied, as I have recommended for many years, the controversy about discs versus fibrositis and fatty nodules would cease, for those who repeat this simple research will find that in a high proportion of cases the pain disappears for the time being This implies that the lesion affects the dura mater The muscles and fasciæ, together with their fatty denizens, cannot under any circumstances touch the dural tube.

THE RADIOGRAPH

Radiographic appearances afford no help in disc-lesions The reason for taking an x ray photograph is that most other painful disorders in the lumbar region do show up radiologically hence the radiograph can be used to exclude most other diseases. That is all A diminished joint space shows the disc to be thinned, it does not show whether or not a protrusion is present. A normal joint space in no way excludes the grossest displacement of disc-substance. Even when a disc-lesion is known to be present, the level at which the radiological evidence suggests that it lies may well be wrong Patients with psychogenic pain may easily possess a diminished joint space.

So far as disc-lesions go the rule is—take an x ray photograph for its negative value only Brailsford (1954) dis cussing radiology in lumbar disc-lesions says No ancillary service is being abused more than radiology Its chief abuses come from its substitution for clinical medicine' How I agree with him!

CHAPTER XVII

THE LUMBAR REGION

PART III: DIFFERENTIAL DIAGNOSIS

AN account follows first of the different levels and varieties of disc-lesions, then of the other disorders that may provoke disc-lesions Finally, disorders causing backache or pain in the lower limb unconnected with the intervertebral discs are dealt with.

DISC-LESIONS

A damaged lumbar disc can move in seven different ways at each joint. Protrusion takes place at each of the five levels. The different signs and symptoms that result are set out below.

THE SEVEN WAYS

1. *Gradual Posterior Displacement*

The symptom is backache, brought on by stooping or lifting, relieved by staying erect or resting. If the protrusion compresses the dura mater centrally, the pain is central or bilateral. If it lies a little to one side of the mid-line, the symptoms are felt at one side of the lower back or in the upper buttock.

The signs are a full range of movement at the lumbar spine, some extremes hurting, some not; often, a painful arc. Examination of the lower limbs reveals no abnormality.

2. *Swift Posterior Displacement*

This results in lumbago. The patient is seized with severe pain in the lower back, coming on instantaneously during bending in the case of a cartilaginous displacement; in the course of hours if part of the nucleus pulposus protrudes.

There is a constant ache, punctuated by severe twinges on an unguarded movement. The pain may radiate to any part of the lower half of the body (dural reference) He is immobilized in flexion or lateral deviation, he hobbles to bed. A cough or sneeze is agonising The signs are (1) articular, (2) dural The articular signs are deformity and painful limitation of movement at the lumbar spine. The dural signs are bilateral limitation of straight leg raising and lumbar pain on full neck flexion

8 *Postero lateral Protrusion*

This may be secondary or primary the former is the commoner

Secondary The patient suffers a number of attacks of backache or lumbago This time, just as the pain in the back is passing off, it transfers itself to one lower limb, front, outer side, or back, according to the level of the protrusion. Pins and needles, numbness and pain in the limb on coughing may be mentioned

The signs at the fourth and fifth levels are limitation of trunk flexion because of pain in the lower limb, one or two of the other lumbar movements hurt in the lumbo-gluteal region limitation of straight leg raising sometimes a root palsy In the elderly the signs are less obvious There is often unilateral backache together with sciatica the pain does not alternate as in young or middle-aged individuals Trunk flexion may hurt in the lower limb but is often of full range, the other lumbar movements hurt in the lumbar region straight leg raising is usually painful at full range evidence of impaired conduction is uncommon.

Primary A young adult develops an ache in the calf or posterior thigh. This gets slowly worse over a period of weeks or months, eventually spreading to the buttock and foot. There is no backache. The signs are pronounced the pain, by contrast, is seldom really severe. Examination shows limitation of trunk flexion, often with lateral deviation the other three lumbar movements do not hurt; marked unilateral limitation of straight leg raising nearly always one or two signs of impaired conduction at the affected root.

4. *Anterior Protrusion in Adults: The Mushroom Phenomenon*

The patient is elderly, my youngest patient to date is fifty-six. He complains that, after standing for ten to twenty minutes, backache develops, abolished at once by sitting down. In due course he notices that if he stands for longer, in addition to his backache, bilateral sciatica makes its appearance and eventually both feet go numb. These symptoms disappear as soon as he sits or lies down. Examination consists in making the patient stand until the pain starts; he is then asked to bend forwards. This abolishes the pain.

Anterior protrusion proceeds silently, causing no symptoms because the displacement does not engage against any tender structure. As the disc is slowly ground to pieces, the gravel passes forward and bulges out the anterior longitudinal ligament Periosteum is raised up by the ligament and two huge osteophytes form. On the radiograph these two beaks can be seen enclosing a round ball of displaced disc-substance (see Plate 16); the vertebral bodies lie in apposition. The mechanism of eventual pain is as follows: when the patient stands, the rubble left in the intervertebral joint exerts centrifugal force on the capsule of the joint all the way round. The loss of thickness of the disc means that the capsule of the joint is lax and can bulge out abnormally far. In front and at the sides, this does not matter; but the posterior component compresses the dura mater and finally the nerve-roots. Bending forward stretches the back of the joint, whereupon contact between ligament and dura mater or nerve-root ceases at once. After many months of this type of intermittent pressure, both ankle-jerks usually disappear.

This disorder has been named by me the "mushroom phenomenon" since it is dependent on capsular bulging all the way round the joint. It is usually mistaken for intermittent claudication; for the patient gets the pain when walking, which is relieved when he sits down. Moreover, he is already at the age when poor pulsation in the arteries at the ankles may be found. Further enquiry elicits the facts that the mere cessation of walking does not alter his pain: he must sit; and that standing without walking brings the symptoms on. A similar history characterizes spondylo-

listhesis when the shelf formed by the vertebra below catches against both nerve-roots.

5 *Anterior Protrusion in Adolescents Osteochondritis*

Between the ages of fourteen and eighteen, the nucleus pulposus may burrow forwards between the cartilaginous end plate and the bone of the vertebral body which suffers pressure erosion If the protrusion reaches the anterior longitudinal ligament, a small triangle of bone is separated at the anterior corner of the vertebral body This body enlarges antero-posteriorly and at lower cervical levels may be seen to be double the normal length on the lateral radiograph

The phenomenon is common at lower cervical, mid and lower thoracic and upper lumbar levels Since excessive weight bearing might well be supposed to help drive the nucleus pulposus into the bone, Wassman (1951) investigated the incidence of this type of anterior protrusion in the thoracic spine of young recruits He found it eight times more common in those from the country than from a town

The disorder causes no symptoms and requires no treatment unless as a result of the vertebral wedging posterior protrusion of disc-substance has also taken place Manipulative reduction, which has to be repeated often at first, is then required (see Plate 12)

6 *Vertical Protrusion*

This beneficent protrusion occurs, unfortunately, at the very lumbar levels where it is least needed. It is not uncommon at the upper lumbar and lower thoracic levels it is rare at the lower two lumbar joints at which it would be so welcome.

There are two varieties

1 *Schmorl's Node* During weight bearing the nucleus impinges against the articular surface of the vertebral body this finally gives way and nuclear material invades the cancellous bone. This diminishes the intra articular pressure, thus obviating painful posterior herniation No pain whatever is felt during this slow erosion of bone, but the radiograph shows the irregularity of the joint line clearly The node is

first seen at the age of seventeen. The x-ray appearances do not alter appreciably later.

2. *Biconvex Disc.* This phenomenon indicates softening of bone, and indicates past rickets, osteomalacia or senile osteoporosis. Normal pressure by the disc on soft bone results in a concavity at many vertebral bodies. The radiograph reveals that the causative force has been exerted diffusely so as to produce a regular concavity; bone has not suffered localized central erosion. The condition is symptomless.

7. *Circular Protrusion*

A damaged disc may flatten out like a pancake and bulge out the capsule of the joint all the way round. Outward pressure on the ligaments pulls on the periosteum and lifts it off the bone. An osteophyte forms to fill in the gap and to bring bone up to its limiting membrane once more. These bony outcrops very seldom become large enough to exert pressure posteriorly; they cup the damaged disc and prevent its further herniation. Moreover, they limit spinal movement, and thus hinder the lumbar movements that would otherwise have taken place and resulted in an intra-articular displacement (see Plate 14)

Osteophyte formation is a beneficent phenomenon, and is the chief reason why nearly all elderly patients do not have constant lumbar pain.

DISC-LESIONS AT EACH LEVEL

First and Second Lumbar Roots

Disc-lesions causing symptoms are very rare at these two levels. Radiological evidence of narrowed joint spaces here is common in elderly patients, and devoid of pathological significance.

Disc-lesions at the upper two joints behave quite differently from those at the lower three. They are nearly always of the pulpy self-reducing type and come and go with changes in posture. They are, in my experience, always irreducible by manipulation. They cause symptoms that may continue unchanged for many years.

First Lumbar Root. The patient complains of pain in the

back radiating to the groin. On account of misleading dural reference, this radiation is a commonplace in low lumbar disc lesions and at first no suspicion of the unusual level is aroused However the patient states that sitting for say twenty minutes brings the pain on, whereupon standing up soon abolishes it. Alternatively standing brings it on and sitting stops it. Moreover the patient complains that if he lets the pain in the groin go on, he goes numb there but I have yet to meet with paræsthesiæ in the buttock, where the greater part of the first lumbar dermatome lies

Examination shows first of all that the patient points to the upper lumbar forbidden area " (see p 401) as the site of his pain The lumbar movements set up lumbar pain in the ordinary way Examination of the nervous system reveals no muscle weakness or alteration in reflexes, but cutaneous analgesia may be detectable at and just below the inner half of the inguinal ligament.

I have made this diagnosis only a few times in my life and Plate 26 shows the radiological appearances in one such case Since the diagnosis was made before the x ray picture was available, and the two fit so well, it would seem to have been correct.

Second Lumbar Root. The symptoms come and go in the same way Standing for some time provokes a pain in the back radiating to the front of the thigh as far as the knee sitting down abolishes it, or vice versa This goes on for years without altering

The lumbar pain is at the upper levels the lumbar movements hurt locally in the expected way, the painful limb is normal in every way I have met a few cases showing cutaneous analgesia I have seen only one case of a patient fixed in flexion by severe pain felt only at the front of one thigh Any effort to straighten up or to walk was impossible and she had been confined to her room for six months, during this time her condition had not altered Manipulative reduction failed sustained traction succeeded, and this elderly lady has now remained well for two years

One case of mine only of second lumbar disc-lesion has come to laminectomy The patient was 40 years old and had complained of anterior pain in the right thigh on lifting for four years Two years later he noticed pins and needles in the

first seen at the age of seventeen. The x-ray appearances do not alter appreciably later.

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First and Second Lumbar Roots

Disc-lesions causing symptoms are very rare at these two levels. Radiological evidence of narrowed joint spaces here is common in elderly patients, and devoid of pathological significance.

Disc-lesions at the upper two joints behave quite differently from those at the lower three. They are nearly always of the pulpy self-reducing type and come and go with changes in posture. They are, in my experience, always irreducible by manipulation. They cause symptoms that may continue unchanged for many years.

First Lumbar Root. The patient complains of pain in the

back radiating to the groin On account of misleading dural reference, this radiation is a commonplace in low lumbar disc-lesions and at first no suspicion of the unusual level is aroused However the patient states that sitting for, say twenty minutes brings the pain on, whereupon standing up soon abolishes it. Alternatively standing brings it on and sitting stops it. Moreover the patient complains that if he lets the pain in the groin go on, he goes numb there but I have yet to meet with paræsthesiæ in the buttock, where the greater part of the first lumbar dermatome lies

Examination shows first of all that the patient points to the upper lumbar forbidden area" (see p 401) as the site of his pain. The lumbar movements set up lumbar pain in the ordinary way Examination of the nervous system reveals no muscle weakness or alteration in reflexes but cutaneous analgesia may be detectable at and just below the inner half of the inguinal ligament.

I have made this diagnosis only a few times in my life and Plate 26 shows the radiological appearances in one such case Since the diagnosis was made before the x ray picture was available, and the two fit so well, it would seem to have been correct.

Second Lumbar Root. The symptoms come and go in the same way Standing for some time provokes a pain in the back radiating to the front of the thigh as far as the knee sitting down abolishes it, or vice versa. This goes on for years without altering

The lumbar pain is at the upper levels, the lumbar movements hurt locally in the expected way the painful limb is normal in every way I have met a few cases showing cutaneous analgesia. I have seen only one case of a patient fixed in flexion by severe pain felt only at the front of one thigh. Any effort to straighten up or to walk was impossible and she had been confined to her room for six months during this time her condition had not altered. Manipulative reduction failed sustained traction succeeded, and this elderly lady has now remained well for two years

One case of mine only of second lumbar disc-lesion has come to laminectomy The patient was 46 years old and had complained of anterior pain in the right thigh on lifting for four years Two years later he noticed pins and needles in the

right knee at night. His symptoms had been regarded as psychogenic. Examination showed a gross deviation of the lumbar spine to the left and that trunk-extension hurt in the thigh. My provisional diagnosis was a neuroma at the second lumbar level and myelography suggested the same. At operation (McKissock) however a second lumbar disc protrusion was disclosed.

The common cause for upper lumbar disc-lesions is fracture of a vertebral body or osteochondritis with coincident damage to the discs. Secondary malignant deposits favour the upper rather than the lower lumbar spine; here they cause gross limitation of lumbar spinal movements together with such weakness of the psoas muscle that the patient may be seen to lift his thigh with his hands when he wants to shift his leg in bed. Lymphadenomatous invasion is a rarity. Meralgia paræsthetica (see p. 438) must be considered, but posture, coughing and the lumbar movements do not affect the pain if the lateral cutaneous nerve of the thigh is involved.

In cases of doubt, an epidural infiltration of 100 c.c. procaine solution should be given diagnostically. Pain due to an upper lumbar disc-lesion is abolished for the time being; if other causes are responsible the pain remains.

Third Lumbar Root

No more than five per cent of lumbar disc-lesions affect this joint. The early symptoms are felt in the mid-lumbar region. The root-pain occupies the whole front of thigh and knee, spreading down the front of the inner side of the knee (see Fig. 17) to just above the ankle. Numbness may be mentioned at the inner knee or anterior leg.

The lumbar movements hurt the back in the expected way. Trunk-extension may hurt in the thigh. Flexion is of full range, and sometimes painful. The full root-syndrome is: weakness of the psoas, weakness of the quadriceps, sluggishness or absence of the knee-jerk; rarely, weakness of the tibialis anterior muscle; pain in the limb on full straight-leg raising; limitation of prone-lying knee-flexion; cutaneous analgesia at the lower part of the dermatome. As is usual in root-interference by disc-lesions, all these signs are seldom present together.

Fourth Lumbar Root

About two-fifths of all disc-lesions occur at the fourth lumbar joint. The patient points to the iliac crest as the level of his lumbar pain When root pain supervenes, it occupies the inner quadrant of the buttock, the outer aspect of the thigh and leg and, crossing over the dorsum of the foot, it reaches to the big toe, which often tingles

Marked lateral deviation, consistent or alternating, characterizes fourth lumbar disc lesions, and in such cases, gross limitation of one side flexion movement is to be expected In less severe cases, a painful arc on side-flexion is often experienced The full root-syndrome is limitation of straight leg raising often bilateral, the pain in the limb being increased by neck flexion weakness of the tibialis anterior and extensor hallucis muscles cutaneous analgesia at the outer part of the lower leg and at the big toe All these signs are seldom present together

Fifth Lumbar Root

About three-fifths of all lumbar disc lesions occur at the fifth joint. The lumbar spine may deviate on trunk flexion but is symmetrical as the patient stands The lumbar movements hurt in the expected way The full root syndrome is unilateral limitation of straight leg raising, with increase in pain on neck flexion, weakness of the extensor hallucis, peroneal and gluteus medius muscles, cutaneous analgesia at the outer leg and big toe wasting of the buttock muscles, sluggish or absent ankle-jerk.

First Sacral Root

The same remarks apply as above except that the weakness is found at the peroneal calf and hamstring muscles, and the outer border of the foot, the heel and the back of the knee may be analgesic.

Adherent Root. As a rule, expectant treatment leads to recovery by accommodation of a herniation (see Fig 64) the nerve-root is freed from pressure and the range of lumbar spinal movements and of straight leg raising returns to normal.

Occasionally cases are encountered in which the symptoms almost disappear but the patient complains that trunk-flexion is limited by a stiffness of the leg. The movement hardly hurts; it just cannot be performed. This state of affairs continues unchanged for years; so far, the longest duration that I have come across is eleven years. A marine aged twenty was seen by me in 1941 and regarded as suffering from a low lumbar disc-lesion; he had 45° limitation of straight-leg raising. He was seen again in 1952; he was a working farmer daily performing the heaviest tasks. His symptoms and signs were both unchanged

In these cases the nerve-root has become adherent to the side of the posterior longitudinal ligament at the point of continued contact Root adherence is suggested when a sciatica goes on and on, never fully recovering; hence the diagnosis cannot be arrived at clinically during the first year of root-pain. If adherence is suspected, epidural local anæsthesia should be induced. If the nerve-root is adherent, the anæsthetic solution cannot force its way between the root and the ligament; hence the injection alters neither the pain nor the range of straight-leg raising, thus confirming the diagnosis.

Fourth Sacral Root

Misleading dural reference can lead to pain felt at the lower sacrum, the coccyx, the penis, the vagina or the rectum. Pain at these sites is thus not evidence of a fourth root lesion. In one patient who had had eighteen months' treatment to his rectum, the range of straight-leg raising was limited to 45° on each side by pain felt in the rectum; the pain was abolished and a full range of straight-leg raising temporarily restored by epidural local anæsthesia. A week later, R. H. Young removed his protrusion. Pins and needles felt in the testicle are a puzzling symptom whose mechanism I cannot understand The twinges that may be felt in the back in lumbago may be experienced deeply in the lower sacral area, *i.e.* in the rectum When this happens, the pain of proctalgia fugax is simulated.

Impaired conduction along this root leads to saddle analgesia and weakness of the bladder. I have so far met with

four cases of bladder paresis one in conjunction with a large fifth lumbar protrusion which was causing pressure atrophy The first was being kept under observation when, three weeks after the onset of the sciatic palsy she complained of bladder weakness. Her disc was removed the following day by R. Furlong The other case was that of a man with recurrent lumbago During each attack he noticed increasing weakness of his bladder, and after his fifth attack in two years he found he was so apt to wet himself that he took to wearing a bag His disc was removed a month later by R. H Young, and adequate control returned

Two interesting cases, perhaps unique, have also come my way

The patient began lumbago at the age of 32 Aged 40, while standing she felt a sudden click in her perineum Instantly her left labium went numb together with a small area to the left of the anus. This analgesia had persisted unchanged when she was seen by me thirteen years later From the moment of the click she lost her libido, which never returned There was neither dyspareunia nor bladder weakness

A medical man aged 28 fell heavily on to his buttocks and hurt his back severely It ached for a week and intermittently after that. A year later numbness appeared on the left at the medial aspect of the lower buttock and the uppermost three inches of the inner thigh The left side of his penis and scrotum became analgesic when erect, his penis deviated to the left. Libido was little affected and the bladder did not become weak. His anus became anæsthetic on the left and defæcation was felt as a unilateral phenomenon only These symptoms largely disappeared after two years but when he was seen by me for his recurrent lumbago at the age of 38, slight cutaneous analgesia at these areas was still detectable.

The fourth sacral palsy followed osteopathy in one of these cases. An orthopædic surgeon has reported one more. This fact has an important practical bearing, for those anxious to deprecate manipulation as a method of treatment harp on the bogy of permanent urinary incontinence It

remains a possibility, however remote, but when the manipulation is carried out without anæsthesia and with the safeguards set out in the next chapter, neither the many hundreds of students taught by me, nor I myself, have as yet precipitated such a catastrophe. Even if in my lifetime I do, let us say, provoke this disaster once, it is at least arguable that to refuse relief to many thousands lest harm be done to one lacks a sense of proportion No surgeon could ever operate if this view prevailed in medicine.

SPONDYLOLISTHESIS

This developmental abnormality sets up pain in two separate ways: (1) By causing a disc-lesion at the unstable joint. (2) By stretching the capsule and the nerve-roots It should not be forgotten that spondylolisthesis may cause no symptoms for the whole of a patient's lifetime. Moreover, laminectomy occasionally shows that the disc-lesion lies at the non-spondylolisthetic joint.

SPONDYLOLISTHESIS WITH SECONDARY DISC-LESION

Nothing in the history arouses suspicion unless the patient states that he has had trouble since childhood. He suffers backache or attacks of lumbago, unilateral or bilateral, indistinguishable from those occurring without spondylolisthesis. If he later develops sciatica, this is unilateral. Epidural local anæsthesia abolishes the backache for the time being.

It is only when inspection and/or palpation disclose the irregularity of the spinous processes that the presence of spondylolisthesis is suspected and confirmed by x-ray photography. The lumbar movements hurt in the manner characterizing a disc-lesion; indeed, the signs and treatment are those of the disc-lesion causing the symptoms.

SPONDYLOLISTHESIS OF ITSELF CAUSING SYMPTOMS

The provocation of backache by spondylolisthesis shows that the ligaments about the lumbar intervertebral joints are

not wholly insensitive After years of stretching they do begin to set up discomfort. The ache is always central and largely unconnected with exertion, some days the back aches, other days it does not, for no clear reason Prolonged standing is apt to cause either backache or discomfort at the outer aspect of both thighs, sitting or lying abates the pain The patient may suffer vague crural numbness at night but wakes comfortable. Thus the history may suggest a pulpy self reducing disc-lesion, but the aggravation by standing rather than by stooping or lifting should warn the physician.

Inspection may suggest an irregularity When the patient's lumbar movements are tested, usually none hurt, even though the back is aching at the time of the examination This finding should lead to renewed scrutiny and palpation of the lumbar spinous processes as the patient stands When he lies prone, this palpation is repeated, in order to discover if the irregularity disappears when weight bearing ceases Epidural local anæsthesia cannot reach the whole capsule about the intervertebral joint, hence it does not affect the pain.

Spondylolisthesis also causes bilateral sciatica, sometimes with, sometimes without, premonitory backache. The patient states that after standing for, say half an hour he develops increasing sciatic pain and paræsthetic feet, such that he is compelled to sit or lie down Such provocation and relief of root pain may go unchanged for years the symptoms are the same as in the mushroom phenomenon (see p 420) but the patient is much younger The forward movement of the listhetic vertebra drags on the nerve-roots, which engage painfully against the shelf formed by the stable vertebra below

CONCEALED SPONDYLOLISTHESIS

The patient describes the typical history of backache, perhaps followed by bilateral sciatica, brought on by standing for some time, abolished by sitting or lying Inspection of the back shows the irregularity, its presence is confirmed by palpation. When the spinous processes are palpated later with the patient prone, no irregularity is detectable Relief from weight bearing has allowed the bone to slide back into

place again. Since most lumbar radiography is carried out in recumbency, the patient brings with him radiographs that disclose no abnormality. Unless he is x-rayed standing up, the displacement is not revealed. A patient with this condition wanders from consultant to consultant for years, often ending with a psychologist. One good look at his back as he stands avoids this series of errors.

Posterior Spondylolisthesis

This usually causes no symptoms except in so far as a secondary disc-lesion may result. In the case illustrated in Plate 20, which followed interference with the lateral articulations at laminectomy, considerable bilateral root-pain had been present for years, disappearing only when the patient lay down.

SPONDYLOLYSIS

This also causes no symptoms unless a secondary disc-lesion with protrusion results. It is detectable only radiologically. Naturally its presence implies potential weakness of the back and it is regarded as precluding full military service or strenuous work. In the case illustrated (see Plate 17) there had been some years' considerable backache. This proved intractable; arthrodesis was advised but has so far been refused.

WEDGING OF A VERTEBRAL BODY

This results from fracture, osteoporosis, adolescent osteochondritis, neoplasm and tuberculous caries.

FRACTURE CAUSING WEDGING

This occurs at the upper rather than the lower lumbar vertebræ. Until the fracture has united, bone pain is felt; it is severe for only a week or two and has certainly ceased at the end of three months. Any pain felt after that is the result of a coincident disc-lesion. Naturally, force sufficient to break bone often also damages the discs above and below

the fracture. Moreover, there is now a permanent kyphosis at these two joints Hence recurrent attacks of pain follow the injury This fact explains why some patients with a fractured body later have severe trouble, while others are symptom free. It is not what happens to the vertebral body but the state of the discs, not visible radiologically, that determines whether symptoms persist after the fracture has united.

Inspection reveals a small angular kyphos slight limitation of movement may be detected Palpation and radiography identify which vertebral body is wedged

Many patients who know a vertebral body to have been fractured allege pain in many it is organic but in some it is assumed or psychogenic. Examination on the lines that detect neurasthenia is required to sort these cases out (see p 650)

SENILE OSTEOPOROSIS

Elderly patients, usually women, with marked generalized rarefaction of the spine may sustain a pathological fracture of one or more vertebral bodies This is more frequent in the thoracic than the lumbar region. The wedging may come on slowly; it is then often symptomless unless a secondary disc-lesion develops on account of the upper lumbar kyphosis at the joints to either side of the collapse If wedging comes on suddenly, bone pain results it may be severe for a week or two and has ceased after two or three months.

The kyphos is visible and palpable, radiography discloses the reason.

ADOLESCENT OSTEOCHONDRITIS (SCHAUERMANN)

This comes on between the ages of fourteen (see Plate 12) and eighteen, as the result of anterior disc protrusion The end plate is affected often at more than one upper lumbar level. Bone is eroded at the osteochondritic area and wedging results Since osteochondritis causes discomfort elsewhere and at the spine involves bone, I used to suppose that this was a condition painful on its own account. However four years ago, when examining a girl of fifteen with mid lumbar pain of six months standing I noted that a

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painful arc was present. This finding appeared to me inconsistent with the concept of bone pain and it seemed possible that the cause of symptoms was disc-pressure at one of the affected and therefore kyphotic joints This proved so; for manipulative reduction was heralded by a click with instant disappearance of pain. At first there were frequent recurrences necessitating repeated reduction as often as each week. The girl is now eighteen and requires treatment about once a month. The radiological appearances have not altered. Since then this concept has been confirmed on further cases. Once more it is found that it is the disc, not the bone, that gives rise to the symptoms.

Calvé's osteochondritis of the epiphysis of the body itself also gives rise to wedging with results similar, I imagine, to fracture. The disorder is most uncommon and no instance has so far come my way.

TUBERCULOUS CARIES

The symptoms are often slight at first but inspection shows the beginnings of an angular kyphos or, if one side of the body is eroded alone, acute lateral deviation of the same type as occurs with hemivertebra. The lumbar spine is kept extended when the patient is asked to bend forward and the range of both side-flexions is markedly limited. These findings naturally call for immediate radiography, which usually reveals the lesion clearly Four times in my life however the first radiograph has revealed nothing in cases eventually found to be tuberculous

LESIONS UNCONNECTED WITH DISCS

A large number of conditions give rise to pain felt in the back, groin and lower limb; all have to be kept in mind in differential diagnosis. All are much less common than a disc-lesion. They are considered first in relation to backache, then on a segmental basis in the lower limb.

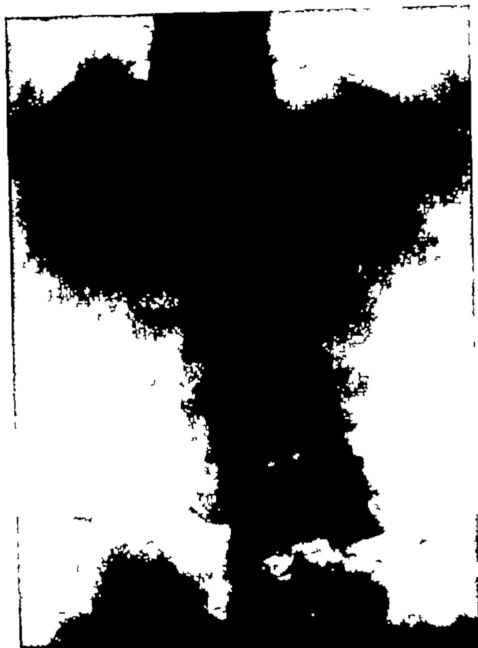


PLATE 21

Attempted side-flexion towards the patient's left does not even result in the spine reaching the vertical position. The block clearly lies at the left side of the fourth lumbar intervertebral joint and a large cartilaginous fragment lying here was removed at operation.



PLATE 22

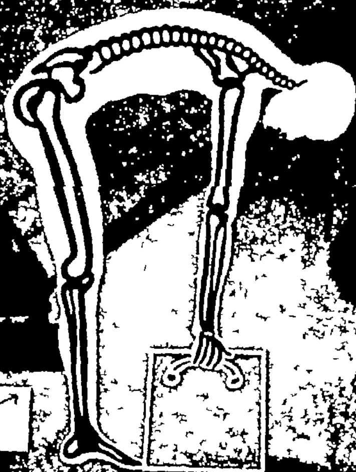
Lumbar hemivertebra This patient had had six months' aching at the back of both thighs

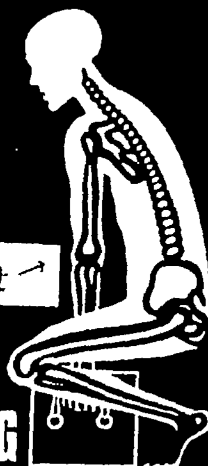


PLATE 23

Marked lumbar kyphos caused by posterior protrusion of part of a low lumbar intervertebral disc with left-sided sciatica. The patient is bending backwards as far as he can.

YOUR BACK IS NOT A DERRICK





LEGS ARE DESIGNED FOR LIFTING

- Stand close to the load
- Take a secure grip
- Keep the back upright
- Take a steady lift — don't jerk
- Have a firm footing
- Bend the knees
- Lift with the legs
- Shift the feet to turn -don't twist the body

PLATE 24

A Canadian poster This was issued by the Workmen's Compensation Board in an endeavour to protect heavy workers from lumbar disc-protrusion



PLATE 25

Epidural injection with lipiodol. The patient is lying on his left side and lipiodol mixed with saline solution has been injected through the sacral hiatus (R. H. Young). The oil has flowed along the nerve-roots. The solution has reached to the third lumbar level.



PLATE 26

First lumbar disc-lesion Radiograph of a man aged 31, whose upper lumbar pain and cutaneous analgesia in the left groin were ascribed on clinical examination to this rare lesion

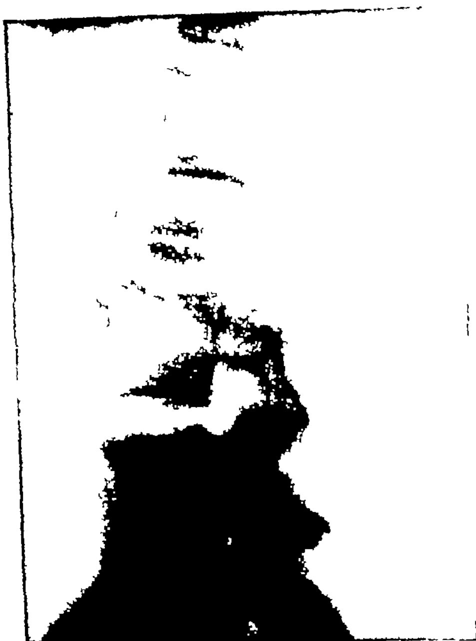


PLATE [illegible]

Localised osteitis deformans at the second lumbar level. This man, aged 40, had had six months backache. An upper lumbar angular kyphos was visible and palpable. Note that collapse continues until cortex touches cortex at the vertebral body. The pelvis showed the typical appearances of osteitis deformans.



PLATE 28

Septic arthritis at the fourth lumbar joint. This man, aged 42, was first seen by me after six months' increasingly severe backache. The radiograph then revealed no abnormality, but the lumbar movements were markedly limited. At the end of a year the ankylosis by bone became clearly visible (see text).

LUMBAR PAIN

1 *Fractured Transverse Process*

This occurs only after direct injury to the back. The pain is unilateral, localized, and felt in the mid or upper lumbar region; for the fifth process is scarcely ever broken. The history and the discovery of pain elicited by resisted movements when the patient lies prone give the clue, and the radiograph is diagnostic. It must not be forgotten if pain persists for more than a fortnight, that force sufficient to break a transverse process may have injured a disc as well; alternatively the idea of a 'fractured spine' may be so attractive to a patient that psychogenic symptoms take over.

Although osteo-arthritis of the lateral articulations may be seen radiologically and may be gross in spondylolisthesis or after severe fracture, I am by no means convinced that appreciable pain results. Again, "kissing" spinous processes cause limitation of lumbar extension but not, in my experience, any discomfort.

2 *Spondylitis Deformans*

If the precedent sacro-iliac arthritis has caused no symptoms, the first complaint may be backache. It comes and goes according to its own vagaries; exertion, however severe, does not evoke the pain though it may aggravate it when it is already present. As a rule, the whole lumbar spine becomes involved at much the same time. Hence the patient, instead of indicating some spot, points to the whole lumbar region centrally. Examination shows a flat lumbar spine with, perhaps, the beginnings of an upper thoracic kyphosis combined with limitation of side-flexion at the lumbar joints. By now the sacro-iliac joints have fused and testing them clinically (see p. 400) does not elicit pain, but an x-ray photograph of these joints—*not* of the lumbar spine—reveals the tell-tale sclerosis.

3. *Osteitis Deformans*

In advanced cases the pain is all over the elderly patient's back. Inspection shows the trunk to have a shortened appearance as if the thorax had come too far down towards the pelvis. Genu varum may be visible. Movement of the lumbo-thoracic spine is grossly restricted. Palpation of femur or tibia may show expansion. The radiograph of the pelvis is diagnostic.

Sometimes one vertebra is affected alone. If so, the body softens, broadens and collapses just as happens in invasion by neoplasm, but does not proceed beyond cortex touching cortex. Localized backache results and inspection shows the angular kyphos. Plate 27 shows the typical appearances. The differential diagnosis is made largely by seeking evidence of osteitis deformans elsewhere; in this case the ilium was affected also.

4. *Neoplasm and Lymphadenoma*

This is nearly always secondary, though primary myeloma is encountered. In myeloma the sedimentation rate is seldom less than 100 mm. in the first hour. There may be a history of previous operation for malignant disease, but undue weight must not be given to this fact; for such patients, like other individuals, often suffer from ordinary disc-lesions. Much distress is caused, and effective treatment not given, when a disc-lesion is mistaken for secondary malignant deposits; hence it is an error hardly less grave than the converse.

The first suggestion of malignant disease is contained in the history, which is not of pain coming and going according to exertion but of steady aggravation irrespective of activity. Then it is found that the pain spreads down both lower limbs in a distribution not corresponding to any one root. Moreover, the backache gets worse when the sciatica, soon bilateral, comes on. In a disc-lesion the backache eases when unilateral root-pain appears. If examination does not yet reveal a kyphos, marked limitation of movement is seen at the lumbar spine, most obvious on attempted side-flexion. Neurological examination reveals signs that more than one

nerve-root is involved, e.g the knee-jerk is affected as well as the ankle jerk, the psoas muscle is weak together with muscles of lower lumbar derivation, the muscle weakness and the site of cutaneous analgesia belong to different segments the signs are bilateral and asymmetrical At the upper two lumbar levels, neoplasm may interfere with the sympathetic nerves If so, the foot on the affected side is warmer than its fellow Unilateral œdema at the foot suggests pressure in the pelvis from metastases. These signs often appear long before the radiograph shows rarefaction and collapse of one or more vertebral bodies. Indeed, a radiograph may show no change only a few weeks before post mortem examination discloses vertebral bodies that can be crushed by the fingers Hence, no reliance can be placed in the short run on x ray photography In a doubtful case, epidural local anæsthesia can be employed, since it abolishes temporarily the pain due to a disc-lesion but not that due to metastatic invasion Alternatively the patient can be x rayed at two-monthly intervals and, if after six months no change is detectable, neoplasm may be regarded as absent

5 *Chronic Osteomyelitis*

The patient, always in my experience male, complains that a slight, constant, central backache came on some months ago and has gradually become more severe Examination at this stage reveals no diagnostic signs and epidural local anæsthesia does not abolish the pain for the time being Radiography reveals no abnormality The patient is kept under observation and as the pain gradually worsens so does restriction of side flexion at the lumbar spine make its appearance. The pain on movement and the increasing limitation of range may suggest spondylitis deformans but the radiograph shows the sacro-iliac joints to be clear Once these points are established, the patient should be regarded as suffering from chronic osteomyelitis Plate 28 shows the appearance at the end of a year in a patient first seen by me six months after the onset of symptoms At this attendance, though the clinical signs were clear the radiograph disclosed no abnormality He was admitted the same day under R. H. Young and in due course x ray evidence of septic infec-

tion of the joint appeared. I see a case of this sort once a year, *i.e.* the incidence is about one in a thousand.

6. *Ligamentous Overstretching*

This is most uncommon except in spondylolisthesis (see p. 428). In myopathy or anterior poliomyelitis affecting the muscles of the lower trunk, the patient has to balance himself bent slightly backwards. This puts a severe strain on the anterior longitudinal ligament; after some time a backache results that is immediately abolished by sitting down or bending forwards. Occasionally after laminectomy a flexion injury may painfully overstretch the fibrous tissue replacing the interspinous ligaments.

7. *Gastric Ulcer adherent to Lumbar Spine*

The symptoms are often remarkable, being connected both with eating and with posture. The pain may be lumbar or felt in one or other iliac fossa; it is not in my experience epigastric. One patient had to eat standing by the mantelpiece; another could not stand up straight after a meal. One patient with only upper lumbar pain obtained ease by frequently drinking hot water. He had twice had his stomach investigated by a barium meal and it was only when another was performed in the Trendelenburg position that the ulcer was revealed.

Trunk-extension stretches the scar tissue at the front of the spine and may cause discomfort—a most misleading finding. However, the lumbar symptoms are felt in the forbidden area; they are not brought on by exertion although they are influenced by posture, and they clearly possess some connexion with abdominal visceral function. This combination brings the diagnosis to mind.

8. *Gonorrhœal Fasciitis*

This is alleged to cause "poker back" but is an entity copied from one text-book to another. I have never encountered such a case and, short of the fascia turning into bone,

I do not believe that it could produce appreciable limitation of movement, in particular towards extension, which relaxes the fascia Clearly the idea of gonorrhœal fascitis depends on the co-existence in one patient of gonorrhœa and spondylitis deformans—both diseases to which young men are prone

9 *Pain Referred to the Back*

When pain is referred to the back from an intra abdominal or pelvic viscus, the outstanding finding is a full and painless range of movement at the lumbar spine This finding focuses attention on the non moving parts of the body the kidney, colon, ovary, uterus and rectum. In cases of doubt, epidural local anæsthesia should be induced since it provides a clear answer there and then

ROOT PAIN

First Lumbar Pain

The commonest cause of pain referred to the groin is misleading dural reference from a low lumbar disc-lesion Far less often it results from a lowest thoracic disc lesion. Pain in the groin was for a few months the only and throughout a prominent, symptom in the case of fourth lumbar neuroma illustrated in Plate 29

Early osteo-arthritis of the hip may set up pain felt only in the groin at first. Intestinal and renal disorders, an ovarian cyst or obturator hernia, may also cause pain felt chiefly in the groin. A gastric ulcer adherent to the lumbar spine sometimes causes puzzling symptoms (see p 486)

Second Lumbar Pain

Pain at the front of the thigh reaching as far as the knee occurs in lesions of structures developed from the second and third lumbar myotomes. These include the hip the psoas, adductor and quadriceps muscles, and the femur itself (*e.g* in osteitis deformans, osteomyelitis or neoplasm)

Psoas or gluteal bursitis is a possibility

Meralgia Parœsthetica This is an interesting condition The patient complains of pain and parœsthesiæ in the area of skin supplied by the lateral cutaneous nerve of the thigh. This nerve emerges from the outer border of the psoas to cross the iliacus muscle. It passes under the outer aspect of the inguinal ligament, and two inches below the anterior superior spine of the ilium pierces the fascia femoris. It emerges superficially two inches lower down, and it would seem that it can be irritated in this part of its course. The difficult distinction between meralgia and a second lumbar root-lesion rests on · (1) A history of pain in the back or upper buttock preceding the appearance of the numbness. (2) Finding that one or more of the lumbar movements hurt in the trunk or provoke the pins and needles. (3) Careful delineation of the parœsthetic area. Comparison of Fig. 72 with Fig. 16 shows that the two areas correspond laterally, but only the second root supplies the front and inner aspects of the thigh. (4) The degree of analgesia. Since the second and third root territories overlap, the numbness is very slight in root-lesions but may amount almost to anæsthesia in pressure on the cutaneous nerve. (5) The induction of epidural local anæsthesia. In a large man up to 100 c.c. are required to be sure of the right level being reached. Naturally this injection abolishes symptoms only in a root-lesion.

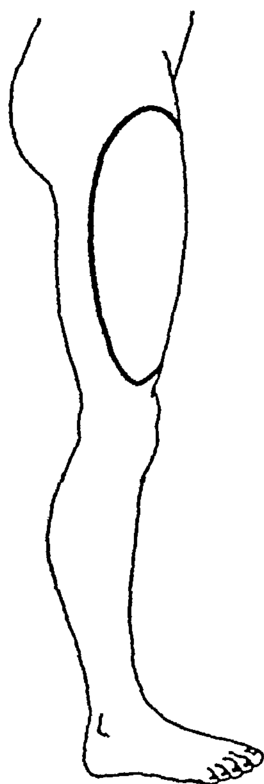


FIG. 72—The area of skin supplied by the lateral cutaneous nerve of the thigh. The anterior edge does not reach to the mid-line of the thigh in front. Contrast the distribution of the second lumbar nerve-root (Fig. 16).

Third Lumbar Pain

Apart from the nerve-root itself, the common source of a third lumbar pain is a lesion of the hip-joint, whose capsule is usually developed wholly within the third lumbar myotome. Indeed, it is a commonplace that, especially in children, pain

at the knee originates at the hip Impaction of a loose body in the knee-joint also gives rise to pain usually more or less third lumbar in extent.

Long Saphenous Nerve This may suffer irritation analogous to the lateral cutaneous nerve. It is exposed to friction at the foramen by which it pierces the fascia just below the inner side of the knee, alternatively its sheath may be damaged by a direct blow or by kneeling The pain may start at the knee, later spreading up the inner side of the whole thigh and down the inner side of the leg to the medial aspect of the foot. In other cases it may start at the inner side of the heel and then extend up to the knee This is a most deceptive story drawing attention away from the knee and suggesting that the pain originates at the foot. The symptoms seldom include paræsthesiæ and walking may increase the pain since the nerve is shifted in its foramen at each knee-flexion movement. Signs of loss of conduction are absent. The only physical sign is a small tender area situated at the inner side of the tibia an inch or so below the knee-joint. This is present on the affected side only, at the foramen where the nerve emerges Local anæsthesia here destroys the pain which seldom returns appreciably

Fourth and Fifth Lumbar Pain

Sometimes the capsule of the hip-joint is derived largely or wholly from the fourth lumbar segment if so arthritis gives rise to 'sciatic" pain Acute lumbago arthritis of both hips spondylolisthesis the mushroom phenomenon and malignant disease of the spine all set up bilateral pain in the limbs. Thrombosis of the external iliac artery may give rise to curious signs suggesting some lesion lying anteriorly in the region of the hip-joint it is only when further examination discloses that the leg and foot on the affected side are cold that the diagnosis is suggested This rule holds for out patients only, for a day or two in bed restores equal warmth to the two extremities. A tight fascial compartment for the extensor group of muscles in the leg may mimic the mushroom phenomenon, especially if pins and needles are felt (see p 584)

Pressure on the peroneal nerve is usually postural rarely it is caused by an osteoma at the head of the fibula. The

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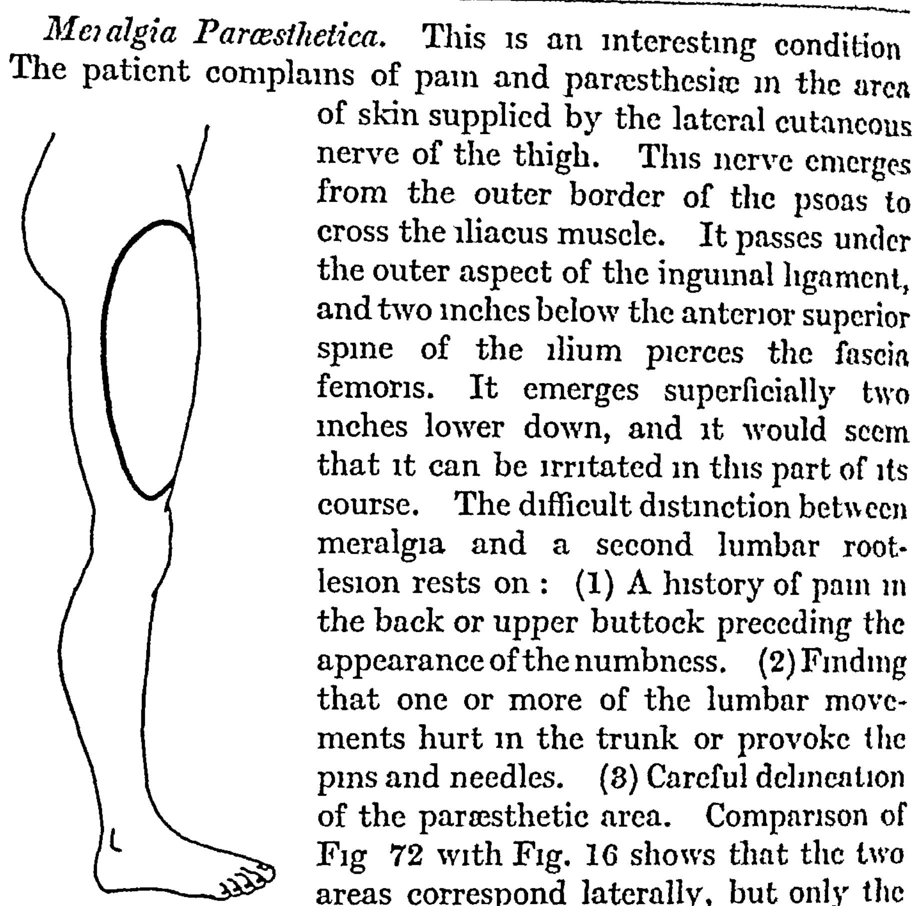


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patient habitually sits with his legs crossed, or with the outer aspect of his knee pressed against a hard edge. In due course pain may be felt to radiate from the knee up the outer aspect of the thigh to perhaps the trochanter, down the outer side of the leg to the foot. Distally, paræsthesiæ may be a prominent feature; as a rule weakness of the dorsiflexor muscles and diminution in cutaneous sensibility are not marked and may be absent. Spontaneous recovery sets in as soon as the cause of the disorder is explained to the patient. The pain itself responds well to the induction of local anæsthesia.

Peroneal Neuritis. This is the name given to sudden foot-drop, occurring unilaterally in elderly patients. The true nature of the condition is unknown; paralysis is the marked feature; the disorder is entirely painless. Careful examination usually reveals some weakness in the hamstring muscles and slight gluteal wasting as well. It is my belief that the lesion, whatever it is, lies not distally but at the sciatic nerve-roots or in the anterior horn cells. It may be the solitary example in the lower limb of the infectious neuritis that occurs at the scapula and upper limb. Spontaneous recovery, so common in the upper limb, does not usually take place. A loose body at the back of the knee-joint can compress the tibial nerve (see p. 554).

First Sacral Pain

The sacro-iliac joints are derived from the first and second sacral segments, hence in early spondylitis deformans the capsular pain often radiates to the posterior thigh and calf. Intermittent claudication also gives rise to pain in the calf and posterior thigh. Bilateral pain results from spondylolisthesis, the mushroom phenomenon and secondary neoplasm. Obstetric palsy results from pressure exerted on the lumbo-sacral cord at the brim of the pelvis. Since the pressure is exerted on a nerve-trunk beyond its dural investment, local pain is absent and straight-leg raising neither painful nor limited. If full foot-drop occurs, the patient naturally reports the fact soon after the confinement; but if only vague numbness and some weakness of the calf muscles are present, the paresis may pass unnoticed until she is up and about again at

home These cases are uncommon and recover spontaneously in a few months—at most, in a year

Neuromata are usually benign and sometimes multiple. Some are found lying superficial to the sciatic nerve-trunk in the thigh or lower buttock. Others are incorporated in the nerve, expanding it from within. Benign neuromata set up pressure effects when they form within the spine Hence the existence of intraspinal multiple neuromata can be inferred when they are found at the trunk or at a limb in conjunction with signs of impaired conduction at a higher level.

Deep phlebitis, osteitis deformans, neoplasm of the ilium or femur and various traumatic lesions of the muscles locally complete the list.

Fourth Sacral Pain

Rectal, penile, scrotal, testicular and bladder disorders are by far the commonest causes. In the uncommon event of a low lumbar disc-lesion being thought the cause, epidural local anæsthesia usually has to be induced diagnostically

COCCYGODYNIA

This may be referred or may arise locally

REFERRED COCCYGODYNIA

This can result from a low lumbar disc-lesion. This was clearly demonstrated in one of my own students whose sciatic pain was transferred to the coccyx during reduction by sustained traction. It is distinguished from a local disorder by the fact that coughing, some of the lumbar movements and, nearly always, straight leg raising increase the pain Local tenderness is marked in referred coccygodynia and a local lesion thus closely mimicked Trial of the relevant movements, coupled with those that detect psychogenic pain provides the diagnostic criteria. This ascription must always be confirmed by epidural local anæsthesia, since this happens also to be the most reliable conservative treatment Rarely invasion of the sacrum by neoplasm of the prostate or rectum gives rise to coccygeal pain only, but the relentless aggravation of pain and early loss of ankle jerks afford the clue

LOCAL COCCYGODYNIA

This mysterious complaint is in reality perfectly sin
The common cause is a flexion injury or direct contusio
the coccyx, usually as the result of a fall in the sitting posit
less often childbirth is responsible. In spondylitis d
mans, fixation of the coccyx affords a minor additional
comfort.

Since the coccygeal segments occupy a restricted local
the pain cannot spread in any direction and is felt at
coccyx only. Sitting, and the act of becoming seated, b
on the pain. Standing and lying do not hurt; walking ca
pain only when the coccygeal fibres of the gluteus maxi
muscle are involved Defæcation sometimes hurts. In
peated subluxation, the patient experiences a painful
on getting up after sitting.

As the diagnosis rests on the subjective basis of the el
tion of tenderness, the elimination of psychogenic case
a matter of importance. These are however much less c
mon than is supposed. The history may help; the u
cause is aversion to coitus. Coccygeal pain of local pro
ance cannot spread; patients with neurotic symptoms
usually eager to describe radiation in various directi
Except in referred coccygodynia, the lumbar movements
painless. In all cases the tests for the sacro-iliac joints
lower limbs (except straight-leg raising) are negative; h
psychogenic symptoms are not difficult to detect if the pat
is given enough rope. When tenderness is sought, it is
to start at mid-sacrum.

Four varieties of coccygodynia occur:

1. Sprain of the posterior fibres of the sacro-coccy
joint-capsule.
2 Contusion of the tip of the coccyx and the tissues
mediately about it.
3. Contusion of the posterior intercoccygeal ligaments.
4. Strain of the coccygeal fibres of the gluteus maxi
muscle. The patient states that the pain is percept
unilateral, and walking may set up discomfort.

Treatment. Massage is almost always quickly effect
(see Vol. II). Injection of hydrocortisone is the alternat

CHAPTER XVIII

THE LUMBAR REGION

PART IV TREATMENT

DISC LESIONS

EVEN in a properly run hospital, errors in the treatment of lumbar disc-lesions are inevitable. The patient lies in bed, the house-surgeon reads out the notes his chief asks a few questions an examination follows during which, let us say, straight leg raising is found limited and one ankle-jerk sluggish. What is the treatment? It is impossible to tell. These signs may be found in a patient with slight aching or with intense pain. Since it is not the severity of the lesion but the amount of pain it causes that largely determines treatment, it is vital that the examiner should provide himself with criteria whereby to judge the patient's sensitivity and sincerity This entails listening to the patient's whole account of his troubles from the very beginning and examining also parts of the body distant from the apparent lesion in order to ascertain his threshold for pain This is a slow and painstaking process, requiring patience and humility Short-cuts lead to error as the growing number of psychoneurotics treated by manipulation, plaster and even laminectomy testifies. They also facilitate the reverse error mistakenly regarding organic pain in an obviously neurotic patient as psychogenic.

Much confusion exists on the conservative treatment of disc-lesions. This diagnosis has left a therapeutic hiatus, largely filled today, alas, by lay manipulators On the one hand, the realization that fibrositis, lumbago, and sciatica result largely from disc-lesions has deprived of their last vestige of theoretical justification the traditional measures represented by drugs (apart from analgesics) vitamins (particularly B_1), radiant heat, diathermy massage, exercises, injection of myalgic spots and nodules, and taking the waters" On the other hand, little has so far come forward

to replace these abandoned types of "treatment"; and the distress of doctors and patients at the apparent absence of effective conservative measures is heightened when they find that the only radical treatment is an operation, by no means always successful, warranted only in extreme cases.

This therapeutic nihilism is quite unjustified, for there are a number of simple treatments, none a *panacea*, each with its due proportion of successes. Few patients prove unrelievable if conservative means are intelligently employed, and it is only for some of these few that surgery need be contemplated at all. In order to show that the phrase "therapeutic nihilism" is justified, the following quotation from the report of the October 1954 meeting of the Orthopædic Association is appended. A panel of seven experts sat under the chairmanship of Professor McFarland.

Q "*One-third of all orthopædic out-patients complain of* low backache. Has the panel any suggestion for coping with this vast number?

A. The panel had none."

1. PROPHYLAXIS

Realization that maintenance of the lumbar lordosis provides the main safeguard against disc-protrusion is proceeding slowly. Æsthetic considerations have held the foreground for a century, *and it is difficult now to get gymnasts to* realize that a reasonable degree of lordosis in children is a great advantage in later life. School medical officers can see to it that exercises towards *trunk-flexion* are carried out sparingly, and that, unless marked kypho-lordosis is present, no effort is made to flatten school-children's lumbar spines If any individual cannot reach forwards far enough to touch his toes he must not be encouraged to practise this useless range of movement. Adult women's backache often dates from lying in bed in "the nursing mother's position"—that is, many pillows propping the thorax and no proper support at the lumbar spine, which droops into kyphosis all day (see Fig. 56). No wonder the posterior longitudinal ligament finally stretches and the beginnings of disc-protrusion are laid down. All patients, including puerperal women, should

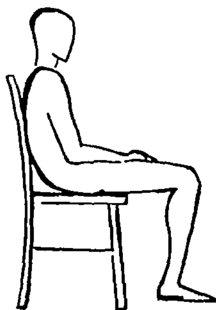


FIG 73.—How not to sit. Note the marked kyphosis at the unsupported lumbar region.

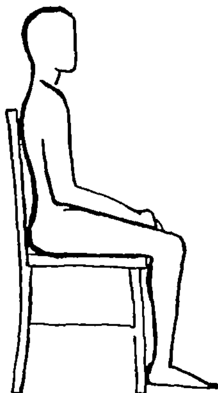


FIG 74.—How to sit.

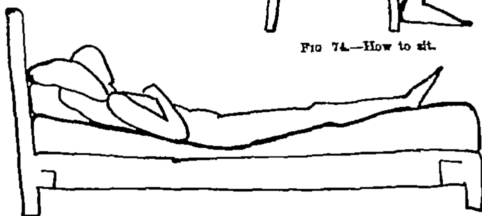


FIG. 75.—Bad posture in bed. So soft a mattress that the patient's lumbar region remains kyphotic all night often initiates a disc-lesion or aggravates an existing defect.

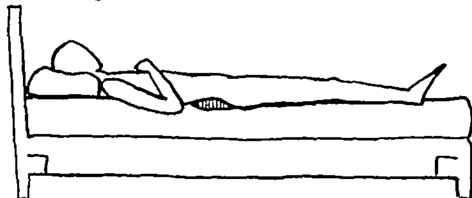


FIG. 76.—Lumbago treated by recumbency As soon as possible, a small pillow is introduced under the lumbar spine in order to maintain lordosis and encourage the intra-articular contents to move anteriorly

altogether for a time and a note to the employer is thus called for. When the patient is engaged in heavy work and has had several relapses, he should be sent to a rehabilitation centre to learn a lighter trade. The question of wearing a belt arises. In cases of recurrent trouble this is usually desirable, and the patient's age, sex and personal inclinations combine to settle the matter.

On the one hand the patient must not be turned into a neurasthenic, afraid to move his trunk at all; on the other,

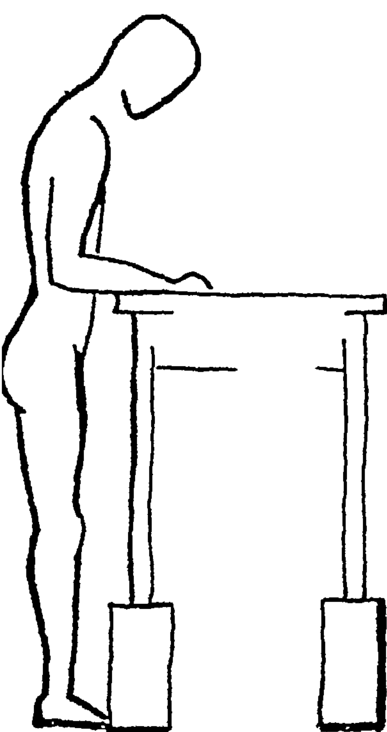


FIG 83.—How to stand at a bench

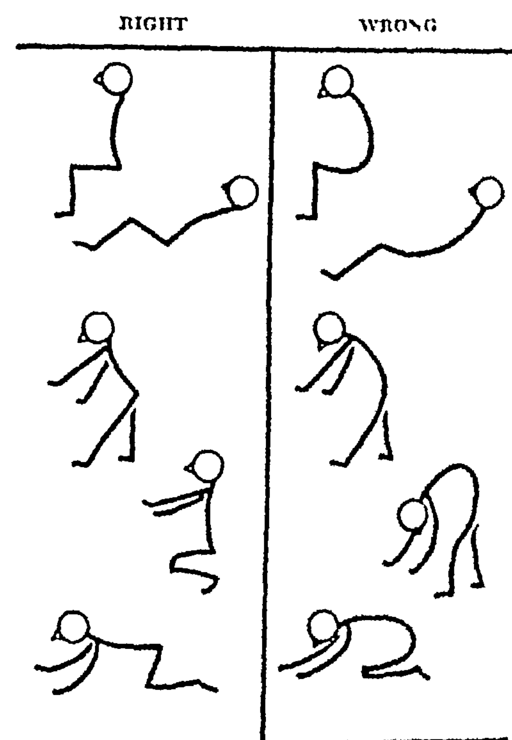


FIG 84.—Posture chart. This card, showing how to avoid re-displacement of low lumbar disc-lesion, is given to patients

he must learn to treat his mechanically imperfect joint with respect. In my experience "a piece of cartilage loose in the joint of the back" is not a frightening idea; it is too simple and concrete a concept. Moreover, stress may be laid on the frequency with which such fragments remain symptomless for years provided that the patient is careful for a time and lets the disorder subside. Many patients with disc-lesions have been told, as a result of misunderstood radiographic appearances, that they are suffering from "spinal

arthritis" This may suggest to them an incurable disease liable to spread to every joint and ending in paralysis or crippledom The purely local nature of the disorder should be explained drawing the analogy with cartilage trouble in the knee, an obviously unprogressive condition, affords much reassurance

8 MANIPULATION

Naturally if something is out of place the most obvious treatment is to restore it to its proper position, it must then be maintained there. Therefore, unless some good reason exists, manipulative reduction should be attempted at once. This measure is universally adopted when a torn meniscus in the knee-joint has moved, but it has been left largely to osteopaths to reduce cartilaginous subluxations at the spinal joints. Without realizing it, they have been doing so for years, to the recurrent discomfiture of doctors. When one considers how unskilled many lay manipulators are and how faulty are their views on the nature of the disorder under treatment, when too, one remembers for how many years patients with severe disc-lesions have been manipulated—often without benefit, it is true, but also without hurt—even under anæsthesia by medical men it is evident that the present change of front towards emphasizing the dangers of manipulating the lumbar spine represents too great a swing of the pendulum

Bonesetters often manipulate a patient, say weekly for as long as he likes to go on coming This practice has bred the idea that manipulation has some prophylactic effect. This is not so for it is impossible to reduce a displacement when it is not present hence manipulation, carried out at a time when there are no symptoms, has no value.

The first decision that has to be made is whether the displacement is reducible or irreducible by manipulation. The reason for the two different responses to manipulation is based on anatomy The protrusion may consist primarily of a fragment of annulus fibrosus or of nuclear material with an intact annulus. R. H Young in an analysis of cases coming to laminectomy, showed that in 50 per cent of his

cases the protrusion was cartilaginous, and in 14 per cent pulpy. My impression is that in patients not requiring operation the proportion is more like two cartilaginous protrusions to one pulpy. Manipulation can nearly always reduce a cartilaginous displacement, but seldom affects a pulpy protrusion. Small and very recent nuclear herniations sometimes respond well, provided that the technique of manipulation is changed from the jerk to sustained pressure.

REDUCIBLE OR IRREDUCIBLE

History

This is often indicative. For example, a patient bends forwards and feels some aching in his back, which gets worse later in the day. Next morning he finds himself unable to get out of bed because of severe lumbago. This history indicates a protrusion that has gradually increased in size—that is, one consisting of nuclear material (see Figs. 62 and 63). By contrast, the patient who is subject to attacks initiated by a click in the back followed by agonizing lumbar pain fixing him in flexion has clearly suffered an abrupt cartilaginous displacement (see Fig. 61). Pulpy protrusions are rare in the elderly; hence any protrusion in a patient aged sixty and over, especially if lumbar osteophyte formation is present, is almost certainly reducible by manipulation, whether causing lumbar, gluteal, or sciatic symptoms.

Primary postero-lateral protrusions causing sciatica are nearly always irreducible by manipulation. This is indicated when a patient with a low lumbar disc-lesion states that his pain began in the calf or thigh without previous backache. Naturally a central displacement impinges first against the dura mater, thus causing backache before it sets up sciatica; primary postero-lateral protrusions never touch the dura at all, hence premonitory backache is absent.

The *self-reducing disc-lesion* is characterized by a different history. The patient wakes comfortable but, as the day goes on, backache develops. This becomes worse especially after exertion or stooping. A night's rest once more abolishes the pain. Naturally, if the posterior bulge at the joint

recedes spontaneously as soon as the compression strain on the joint is released, only to recur when the joint bears weight again, the reduction brought about by manipulation is equally unstable and ephemeral

The *mushroom phenomenon* (see p 414) is another result of compression, it, too, is not amenable to manipulation *Spondylolisthesis* with a secondary disc-lesion is treated in the same way as an uncomplicated disc-lesion, but when capsular stretch is the cause of pain manipulation is of course useless, but quite harmless

Physical Signs

Of these, the appearance of the patient's back is the most informative Much lateral deviation visible as he stands or brought on by trunk flexion suggests a large protrusion often at the fourth lumbar level, difficult to reduce By contrast, a painful arc, with or without momentary deviation, is a good sign, for it suggests a small mobile fragment. If one of the lumbar movements other than flexion hurts in the thigh or calf rather than in the back or upper buttock, manipulation seldom succeeds. Experience has taught me that reduction by manipulation may prove difficult or impossible in patients who have their greatest pain on pinching the lesion *i.e* on side-flexion towards the painful side.

Markedly impaired conduction along the relevant root shows the protrusion to be large. Hence this finding should be regarded as an indication of irreducibility, whether the lesion was originally of cartilage or pulp Displacement of a fragment of annulus may later be followed by extrusion of nuclear material along the line of the fracture This leads to severe compression of the nerve-root and proportionate interference with conduction Thus, weakness of more than one muscle in the leg, combined with, say, loss of ankle-jerk cutaneous analgesia, or much gluteal wasting, shows that this secondary event has supervened Occasionally, however these signs mislead. In recurrent sciatica, the weakness, etc., may have lasted since a previous attack and only a small and recent protrusion, quite easy to reduce, may now be present.

In general, the symptoms and signs of irreducibility run parallel. If, as happens sometimes, they point in opposite directions, it is always worth while making one attempt Manipulation carried out with the safeguards described does not make patients worse. Therefore, in cases of doubt the endeavour should always be made provided that the patient, once he has been apprised of the situation, is willing. He nearly always is. At worst, no harm will accrue; a chance of affording immediate relief from pain has not been missed; moreover, the physician ensures that he will not later add one more to bonesetters' triumphs over doctors

CONTRA-INDICATIONS TO MANIPULATION

Manipulation is contra-indicated in all lumbar disorders not caused by disc-lesions (except in spondylitis deformans)

A complaint of frequency of micturition, paræsthesiæ felt in the scrotum, saddle-numbness at the buttocks or insensitiveness of the rectum naturally suggests pressure on the fourth sacral root. These symptoms call for immediate laminectomy and provide an absolute contra-indication to manipulation Pain referred to the coccyx, labium, testicle or penis may merely be an example of misleading dural reference, and not true evidence of a protrusion dangerously poised. However, I for one regard this reference as calling for caution and do not manipulate in these cases. Never having attempted manipulation in the presence of this type of referred pain, I naturally cannot be sure to what extent this apparent danger is real

Another event shows that the case is unsuited to manipulation. During the first manipulation (lumbar extension. central) a patient with root-symptoms may feel the pain shoot down his limb as the pressure on his back mounts; this means that the protrusion is being forced towards rather than away from the nerve-root and naturally shows that the attempt should be abandoned. If after the first manipulation the patient stands up and the signs and symptoms have increased, no more should be done. If, as may happen in acute lumbago, the pressure of the manipulator's hands causes the patient severe pain, it is unreasonable to go

on and instead epidural local anæsthesia should be induced, the patient being left to lie with the trunk in extension for an hour afterwards

Many neurotic patients are not prepared to stand manipulation, even if it is clear that very little will put them to rights. It is my practice to explain the nature of his disorder and the object of treatment to such a patient, but then to go on to explain that his hypersensitive state precludes a trial of the treatment otherwise called for If he disagrees, the attempt is cautiously begun and continued or stopped according to his reaction.

Psychogenic backache must not be treated by manipulation, indeed, no form of continued physiotherapy is indicated A fortnight's stimulating measures in the company of others, *e.g* in the posture class, may convince a patient that he feels better and is indicated in patients who do not appear suitable for psychotherapy (see Chapter XXIV) Attendance at a posture class also provides a useful test in doubtful cases, for lumbar exercises nearly always make organic backache worse

Technique of Manipulation

Manipulation, then, is carried out unless some contraindication exists. In practice it is found that about two-thirds of all cases prove amenable to manipulative reduction more often if the complaint is lumbar rather than in the lower limb The patient lies prone on a low firm couch and the extension and rotation strains described in Vol. II are applied. After each attempt, the effect is estimated by, *e.g*, if coughing hurt originally, asking the patient to cough if straight leg raising was limited, ascertaining its range again, if one or more trunk movements hurt, asking the patient to stand and try them again. In my experience, manipulation is successful quickly or not at all, hence one, two, three, or at the very most four sessions are required Each lasts about half an hour for no patient, however willing can relax adequately after this time and it is useless to go on.

In hospital practice, the orthopædic physician may easily see ten reducible disc-lesions in an afternoon Clearly, his

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Manipulation is contra-indicated in all lumbar disorders not caused by disc-lesions (except in spondylitis deformans).

A complaint of frequency of micturition, paræsthesiæ felt in the scrotum, saddle-numbness at the buttocks or insensitiveness of the rectum naturally suggests pressure on the fourth sacral root. These symptoms call for immediate laminectomy and provide an absolute contra-indication to manipulation. Pain referred to the coccyx, labium, testicle or penis may merely be an example of misleading dural reference, and not true evidence of a protrusion dangerously poised. However, I for one regard this reference as calling for caution and do not manipulate in these cases. Never having attempted manipulation in the presence of this type of referred pain, I naturally cannot be sure to what extent this apparent danger is real.

Another event shows that the case is unsuited to manipulation. During the first manipulation (lumbar extension. central) a patient with root-symptoms may feel the pain shoot down his limb as the pressure on his back mounts; this means that the protrusion is being forced towards rather than away from the nerve-root and naturally shows that the attempt should be abandoned If after the first manipulation the patient stands up and the signs and symptoms have increased, no more should be done. If, as may happen in acute lumbago, the pressure of the manipulator's hands causes the patient severe pain, it is unreasonable to go

on and instead epidural local anæsthesia should be induced, the patient being left to lie with the trunk in extension for an hour afterwards

Many neurotic patients are not prepared to stand manipulation, even if it is clear that very little will put them to rights. It is my practice to explain the nature of his disorder and the object of treatment to such a patient, but then to go on to explain that his hypersensitive state precludes a trial of the treatment otherwise called for If he disagrees, the attempt is cautiously begun and continued or stopped according to his reaction.

Psychogenic backache must not be treated by manipulation, indeed, no form of continued physiotherapy is indicated. A fortnight's stimulating measures in the company of others, *e.g* in the posture class, may convince a patient that he feels better and is indicated in patients who do not appear suitable for psychotherapy (see Chapter XXIV) Attendance *at a posture class also provides a useful test in doubtful cases* for lumbar exercises nearly always make organic backache worse.

Technique of Manipulation

Manipulation, then, is carried out unless some contraindication exists. In practice it is found that about two-thirds of all cases prove amenable to manipulative reduction, more often if the complaint is lumbar rather than in the lower limb The patient lies prone on a low firm couch and the extension and rotation strains described in Vol. II are applied After each attempt, the effect is estimated by *e.g.*, if coughing hurt originally, asking the patient to cough, if straight leg raising was limited, ascertaining its range again, if one or more trunk movements hurt, asking the patient to stand and try them again In my experience, manipulation is successful quickly or not at all hence one, two three, or at the very most four sessions are required Each lasts about half an hour for no patient, however willing can relax adequately after this time and it is useless to go on

In hospital practice, the orthopædic physician may easily see ten reducible disc-lesions in an afternoon Clearly, his

diagnostic work would cease were he to reduce this number of displacements himself. It is therefore my practice to delegate almost all these treatments to physiotherapists trained—as all St. Thomas's students are—in these methods. Doctors in general practice clearly have not time, inclination or a suitable couch for carrying out such manœuvres themselves; moreover these methods have been found suitable for such delegation.

Anæsthesia

General anæsthesia must not be employed, otherwise the manipulator is left entirely in the dark. Shall he do this manipulation or that? Shall he go on or stop? Only with a conscious patient is he able to judge his next move, let alone be sure of not making the patient worse—perhaps lastingly. The disc-lesion that has previously been reduced under anæsthesia is, in my experience, just as easily reduced on another occasion without These considerations far outweigh the additional relaxation afforded by general anæsthesia. When manipulation under anæsthesia is attempted because it has failed without, renewed failure is to be expected; for it is not the manipulation that is at fault but the protrusion which is irreducible, anæsthesia or no anæsthesia.

Exception. Manipulation under anæsthesia is justified in one rare set of circumstances only. The patient is brought in on a stretcher, having been suffering for some days from agonizing lumbar twinges at the slightest attempt at movement. Epidural local anæsthesia is induced but fails to relieve the pain. This unexpected event shows that the protrusion is exerting such pressure that the solution cannot be forced between the dura mater and the bulging posterior longitudinal ligament. There is nothing for lumbago as acute as this except immediate manipulation under anæsthesia.

4. SUSTAINED TRACTION

Distraction at the affected joint has three effects:

(1) Increase in the interval between the vertebral bodies, thus enlarging the space into which the protrusion must

recede. (2) Tautening of the joint capsule. Naturally, when the slack is taken up, the ligaments joining the vertebral bodies exert centripetal force all round the joint this tends to squeeze the pulp back into place (3) Suction

Sustained traction merely represents a way of achieving in a very short time the same effect as rest in bed for some weeks

Bands encircle the patient's mid thorax and pelvis as he lies on the traction-couch (see Fig 85), they are attached to hooks at each end of the couch The lower band must not engage against the iliac crest, otherwise it sets up intolerable discomfort. Both harnesses are well padded with sheets of sorbo-rubber 1 cm to 2 cm thick (see Fig 86) A spring balance intervenes between the pelvic band and the hook at the

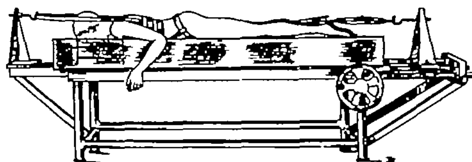


FIG 85 —Traction-couch. When the wheel is turned, the foot-piece moves distally The amount of pull is recorded on a spring balance.

foot of the couch It has two purposes (1) to measure the amount of pull so that a uniform tension can be maintained throughout the session and the same force used at each attend ance (2) to take up slack if the band slips a little If nothing elastic intervenes, all the distracting force is lost if either of the bands slips distally The spring balance takes up the slack patients require one to two hundred pounds traction for half to one hour Plate 30 shows the amount of dis traction obtainable at the lumbar spine, two x ray photographs have been superimposed one taken before, one during, traction the iliac crests form the base line and have been made to coincide If the reader compares the amount of distraction possible at the lumbar with that possible at the cervical joints (see Plates 5 and 6) he will see why manual traction is such a great aid to manipulative reduction at the cervical spine and so very little help at the lumbar spine

A few seconds' traction on the neck almost doubles the width of the joint space; half an hour's strong mechanical traction increases the width of a lumbar joint by only a tenth of an inch. This explains why I had previously found manual traction during lumbar manipulations to be of no added assistance. If manipulation is attempted during strong mechanical traction, the physician will find that the

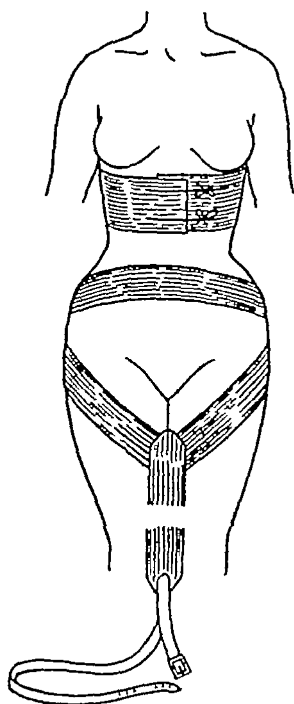


FIG 86—Harness for traction Anterior view

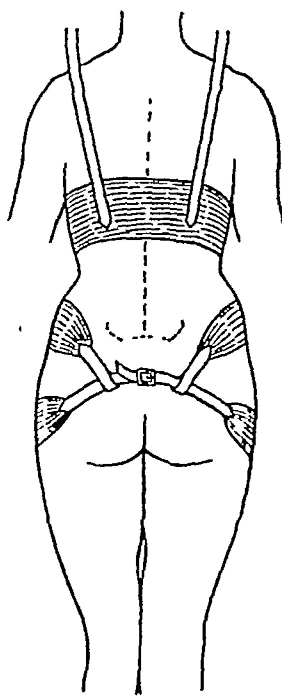


FIG 87 Harness for traction Posterior view

lumbar region is so taut that he can seldom make an appreciable impression on it manually. The induction of epidural local anæsthesia immediately before traction helps a patient to relax.

The physiotherapist stays with the patient throughout his treatment. She may find that any one patient does better prone or supine; she adjusts the traction to the maximum that the patient can comfortably bear, and maintains this pull for as long as is reasonable, some 30 to 60 minutes once or twice a day. A small woman may need 100 lb., a large man up to 200 lb.

As soon as the traction is applied, most patients lose their

pain, since the articular surfaces cease to exert their centrifugal pressure on the nuclear protrusion. Straight leg raising is estimated at each attendance before treatment. When reduction is almost complete, this fact is often signalled by the appearance of a painful arc on straight leg raising Treatment must be given daily until reduction has been secured this takes one to three weeks If twelve sessions have done no good, traction should be abandoned The only exception is the long standing backache of youngish persons in whom the lumbar movements other than flexion are of full range and painless, but straight leg raising is markedly limited on both sides Their only hope of avoiding permanent disability is sustained traction, which is justified daily for at least two months

The institution of this method of treatment seven years ago has proved an enormous help Patients with a nuclear protrusion for whom no treatment existed except prolonged rest in bed or laminectomy now fall within the scope of conservative treatment for the first time As a result my laminectomy rate, which used to be 1 40 has fallen to 1 200

INDICATIONS FOR TRACTION

Unlike the state of affairs at the cervical joints where the indications for traction and manipulation are wholly separate, at the lumbar joints these two methods are to some extent interchangeable While it is true that some protrusions prove irreducible by traction yet reducible by manipulation and vice versa, others respond to both measures However, since manipulation is so much the more quickly effective if the choice is in real doubt, manipulation should be tried once If it fails, no time is lost, and the patient feels assured that he is attending for the slower method of securing reduction with good reason Sometimes considerable improvement may be achieved by manipulation, the residual displacement not proving amenable to further attempt. Even so such partial reduction saves the patient several sessions of traction

1 *Pulpy protrusion* The history of gradual onset coupled with signs of irreducibility by manipulation are present. The main ones are trunk side-flexion towards the painful side

increases pain; trunk movements other than flexion hurt down the lower limb, primary postero-lateral protrusion.

2 *Indeterminate protrusion.* The consistency of the protrusion is uncertain, manipulation has been tried and has failed or been only partly successful.

3. *Relief from pain.* Cases of sciatica of some months' standing are encountered in which the treatment of choice is to leave the protrusion where it is and await spontaneous recovery, meanwhile making the period of waiting bearable by means of the relief usually secured by the induction of epidural local anæsthesia. Should the injection afford no lasting ease, traction is called for and should be continued until the symptoms are slight but straight-leg raising remains limited. In this way, reduction is avoided and the mechanism of spontaneous cure appears not to be interfered with; in other words, the tendency to recurrence is obviated

4. *Fourth sacral reference.* If reduction is to be attempted in cases with pain referred to the genital area of coccyx, traction must be attempted with caution at first. Manipulation is contra-indicated. Even this measure is not quite safe; for marked weakness of the bladder developed immediately after a session of traction in one patient (unhappily not seen by myself) so treated at St Thomas's Hospital. Laminectomy was performed the next day and full control was restored.

5. *First and second lumbar disc-lesions* I have never yet succeeded in reducing a displacement at these two levels by manipulation By contrast traction is often successful.

6. *Recurrence after laminectomy* Manipulation is seldom successful, but can safely be attempted. Traction is more often effective but the prognosis is of course less favourable in those who have, than in those who have not, had the operation.

CONTRA-INDICATIONS TO TRACTION

Sustained traction is not required for pure cartilaginous displacements; these should be reduced by manipulation This applies particularly to elderly patients whose protrusions nearly always respond better to manipulation than traction.

Lumbago with acute twinges is usually aggravated by

traction the patient has even more severe twinges lasting some hours when the traction is released, and may be unable to get off the couch for an hour or two When at last he can, he finds himself no better for his ordeal

Elderly patients with impaired cardiac or respiratory function may find the thoracic band too much of an embarrassment.

A nuclear protrusion in a young patient of some months standing should be left alone. If it is allowed to erode (see p 372), it accommodates itself in a position from which redisplacement is impossible, and the patient is cured If reduction is successfully accomplished the *status quo* is restored and recurrence rendered probable Hence, unless the pain remains severe—it very seldom does—a better and more lasting result is achieved by the avoidance of effective treatment.

5 EPIDURAL LOCAL ANÆSTHESIA

The induction of epidural local anæsthesia is regarded as difficult and dangerous by most authorities So far I have used this method on unprepared out patients some 18,000 times without ill-effect and have found it impossible to introduce the needle properly in less than one per cent of all cases In France, Sicard and Cathelin described the technique of the injection separately in 1901 there is thus nothing new about the method, only in its application.

INDICATIONS

1 In acute lumbago the cause of the pain is a central posterior protrusion impinging on the dura mater If this membrane is anæsthetized by 50 ml. of 0 5 per cent procaine solution, introduced extrathecally via the sacral canal, the protrusion presses on a membrane no longer sensitive and all pain ceases for the duration of the analgesia—that is, one to two hours During this time a patient can move freely perform some essential work, or go home to bed. He can be asked to lie for an hour in hyperextension thus initiating reduction by adopting a lordotic position that pain would otherwise have prevented

2. If a patient with a pulpy protrusion finds traction very uncomfortable, he may be given an epidural infiltration first, so that, pain being abolished, he can relax well during a long pull.

3. Lumbar or sciatic aching that continues *after* reduction of a prolapsed disc may prove troublesome; it is apparently due to persistent local bruising of the dura mater. One or two epidural injections usually suffice to stop it.

4. Chronic backache, especially if it is more severe at night than by day, associated with very slight articular signs at the lumbar spine can often be lastingly abolished by one induction of epidural local anæsthesia.

5. If progress while awaiting erosion is unduly slow, mobilization of the nerve-root under local anæsthesia may have a lasting result. After the epidural injection, straight-leg raising usually becomes painless and of full range, and this increased range and freedom from pain often persists.

6. Referred pain in the groin and referred coccygodynia. When a low lumbar disc-lesion appears responsible, an epidural injection must be performed to corroborate this tentative diagnosis. Happily, it often proves curative as well.

7. Backache caused by a disc-lesion and unaffected by manipulation or traction

TECHNIQUE OF EPIDURAL INJECTION

This is a simple procedure, suitable for out-patient use. The patient lies prone. He must relax his gluteal muscles since, during contraction, they lift the palpating finger off the posterior aspect of the sacrum. The physician identifies the cornua as two bony prominences just to either side of the mid-line at the fourth sacral level (see Fig. 88). The gap between the cornua indicates the position of the sacral hiatus, the lower extremity of the sacral canal. This is continuous with the neural canal of the lumbar, thoracic and cervical region of the spine. The canal is closed above by the dural attachment round the foramen magnum of the skull. The physician should stand on the patient's left side, palpating the cornua with his left thumb and keeping his right hand free for inserting the needle. After superficial sterilization locally (*e.g.* with acriflavine in water 1 : 1000),

the skin and subcutaneous tissue over the hiatus are rendered anæsthetic with a 2 per cent solution of procaine with adrenaline injected from a small syringe with a fine needle Not more than 1 c c. should be used, for too much solution obscures the bony landmarks The physician grasps an

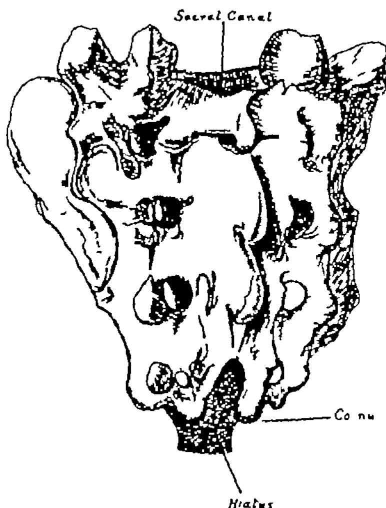


Fig. 88.—Anatomy of the sacrum. The needle is inserted into the sacrum via the hiatus between the cornua.

ordinary lumbar puncture needle, equipped with a stylet, and thrusts it through the spot in the skin already anæsthetized, just below the hiatus He must now consider the direction the needle must take, for the angle at which it is passed depends on the obliquity of the sacrum, estimated visually The tilt of the sacrum varies so much from one individual to another that he may have to aim anywhere between the patient's occiput and his umbilicus.

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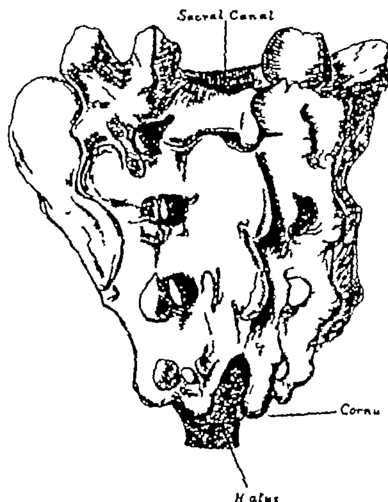


Fig 88.—Anatomy of the sacrum. The needle is inserted into the sacrum via the hiatus between the cornua.

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There are occasional difficulties, but less than one per cent of sacra have proved impenetrable. Many women possess a thick layer of subcutaneous fat over the sacrum, obscuring the cornua. If these cannot be felt at all, the needle is used instead of the thumb for palpation. It is inserted at the correct level strictly in the mid-line, and the sacrum tested fan-wise until the soft spot is found. A lower sacral spina bifida may allow the needle, correctly inserted, to emerge again; alternatively the point may lie in the roof of fibrous tissue closing the defect instead of within the canal itself.

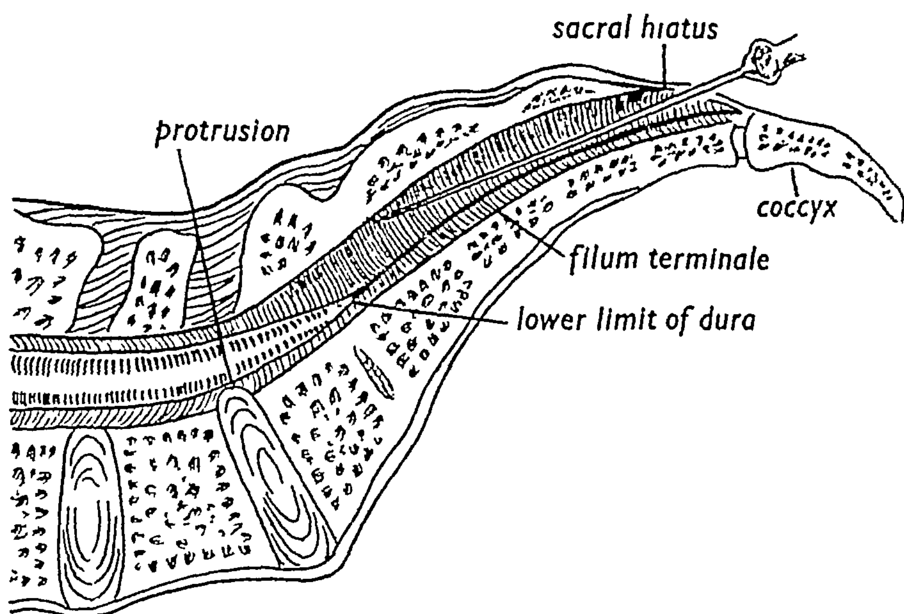


FIG. 89.—Epidural injection. The needle in position.

In most patients, the theca ends at the lower level of the first sacral vertebra, and the needle must stop short of this line. Hence, the needle is passed to a depth of two and a half to three inches. If it catches against an intrasacral bony projection it must be withdrawn a short way and thrust in again in a slightly different direction. If necessary the needle may be rotated through 180°, so as to alter the direction of the slope on its point. The stylet is withdrawn as soon as the needle is far enough in (see Fig. 89).

Care is taken to see that neither cerebrospinal fluid nor blood escapes. A 50 c.c. syringe, full of 0·5 per cent procaine in normal saline, is attached to the needle. Suction is

applied to make sure that the tip of the needle has not pierced the theca or a vein during this manœuvre If all is well, the solution is run in at the rate of 5 or 10 c.c a minute depending on the patient's sensations. If he feels no appreciable local discomfort, or dizziness, or headache, the solution is put in at a fair rate, if it is uncomfortable or engenders any of these symptoms, the physician pauses until they have passed off before introducing any more of the solution The patient should be engaged in quiet conversation during the injection, since the earliest warning of adverse effect is usually a faltering voice. No more should then be run in until the patient feels restored Given with these precautions, the injection is found only vaguely unpleasant. This is an important point for the injection often has to be repeated and must therefore be so given that the patient does not dread it on a future occasion. The physician does not hold on to the butt of the needle with his left hand, once the syringe is affixed He places this palm flat on the patient's sacrum, where it is ready to feel a projection mounting on one or other side. This is his main safeguard against a misplaced needle. Since there exists no test proving that the needle lies intrasacrally, his hand lies ready to feel fluid distending the sacrospinalis muscle. A hint of error is also afforded by the pressure needed for the infiltration No force to speak of is required to send the fluid into a potential space, whereas distending a muscle so ensconced by bone meets considerable resistance. This difference in pressure is soon learned if the physician is careful always to use the same syringe Infiltration of the muscle has no harmful effect, the disadvantages are purely negative. It is, however, essential for him to know that the mistake has been made, so that a false diagnostic conclusion may be avoided.

As the solution runs in most patients feel some lower sacral aching sometimes referred to the back of both thighs. A sufferer from sciatica nearly always states that the pain in the limb is reproduced after 20 or 30 c.c., depending on the patient's size. Though the solution bathes the nerve-roots on each side equally, it is only the sheath already irritated by pressure that is tender enough to set up further pain as the acid solution reaches it. An indication of the level

investment of a low lumbar nerve-root, this fact is no longer appreciated by the patient and in lumbago the lumbar movements, neck-flexion and coughing cease to hurt; in sciatica, straight-leg raising becomes of full range and painless. This result is attained if the fluid, as it forces its way upwards, can infiltrate between the projection and the sensitive membrane. This is not possible if the nerve-root is adherent. Again a huge projection, especially if compressing a nerve-root, applies itself so firmly that the solution is prevented from reaching the exact spot. For this reason the injection seldom has any effect in severe sciatica with marked signs of impaired conduction at the nerve-root; it rarely fails in lumbago.

The solution cannot, of course, enter the joint and anæsthetizes only the dural aspect of the posterior longitudinal ligament; it cannot reach the surface of capsule of the joint except postero-laterally. It does not paralyse the lumbar muscles or the skin (except, rarely, in the saddle area) or the sphincters; hence the patient can walk home as soon as he wants to. It was the employment of this injection that first proved to me the great frequency of disc-lesions as the cause of what, for want of a better term, I had been calling "fibrositis." In the *Lancet* in 1945 I invited those who did not believe that lumbago resulted from a disc-lesion to induce epidural local anæsthesia on a number of sufferers and thus determine whether or not the symptoms were of dural provenance. Many disagreed with me then; some still do; but all on enquiry have failed to carry out this simple test.

Diagnostic Advantages

The injection is invaluable diagnostically; for it gives clear answers in just those minor cases in which the physical signs are slight and difficult to interpret. In sacro-iliac arthritis or strain, in lumbar spondylitis deformans, in chronic osteomyelitis, in secondary neoplasm, in one type of spondylolisthesis, the pain does not arise from irritation of the dura mater. It therefore continues unaltered after the epidural induction. In difficult cases the injection must always be employed diagnostically. This is particularly

advisable when the pain is felt, e.g in the groin, otherwise the orthopædic physician cannot make himself credible to his colleagues who are naturally loath to accept a diagnosis transgressing simple anatomical facts (see p 884) When the patient feels fit to stand, his lumbar movements are tested again, to see if they have ceased to hurt. If straight leg raising was limited, its range is assessed again.

Some authorities recommend that the injection should be given under general anæsthesia. This creates a great palaver over a very simple matter, since it calls for a hospital or nursing home bed, the presence of another medical man and so on. Much time is wasted and much expense either to the State or to the patient occasioned to no purpose. I for one should never get through my work at all if I had to wait and arrange for in patient inductions. Moreover, diag nostic induction becomes impossible, since the patient clearly is seldom composed enough within ninety minutes after general anæsthesia to repeat a number of movements and state whether or not they still hurt.

Therapeutic Advantages

The injection also has therapeutic results When given for this reason the patient should attend weekly This gives plenty of time for any subsequent soreness to have passed off, so that he can give a clear statement whether or not he has improved. If he has not, repetition is without avail. If he has, a second will help again, but not so much Little further benefit follows injections beyond four though I have, at hospital patients' request, given up to thirty weekly injections in intractable cases.

A lasting result from local anæsthesia is difficult to explain, but four hypotheses, not mutually exclusive, can be put forward (1) In lumbago, when movement is markedly limited the patient is free to move for ninety minutes and may thus initiate reduction of the displacement. (2) In patients with minimal articular signs and constant discom fort, or aching only at night, the contact between posterior longitudinal ligament and the dura mater is slight. Hence, if the solution merely separates these two surfaces making them more mobile in relation to each other, symptoms may

be relieved. The likelihood of such a hydraulic effect being the cause of benefit is small, however; for my experience of epidural injection with normal saline solution without procaine is that it is unsuccessful. (3) Some degree of lasting analgesia follows local anæsthesia induced at a nerve in a limb. Thus analogy suggests that, since the theca is the sheath of the spinal cord, it, too, might be susceptible to slight lasting analgesia, with resultant relief from the pain caused by contact. (4) Lastly, when spontaneous recovery in sciatica is unduly delayed, the sheath of the nerve-root may be regarded as having been mobilized under local anæsthesia.

CONTRA-INDICATIONS

These are few, since local anæsthesia cannot of itself do lasting harm.

Local Sepsis. Since the introduction of bacteria into the neural canal is a disaster, the risk must not be taken. Hence, if a needle has to be reinserted, a fresh one should be used. The injection must be postponed if the neighbouring skin is not clear from sepsis.

Previous Laminectomy. The space into which the solution should flow no longer exists; organized blood-clot has formed dense fibrous tissue and fills the canal. Hence, the fluid cannot pass upwards and the injection is fruitless. This is not a certainty, however, and in a small proportion of cases the injection has proved an immediate therapeutic success.

Sensitivity. Patients may state that they are sensitive to procaine. My experience is that this is a very rare event; they are sensitive instead to adrenaline. However, it is best to make sure. Ten c.c. of 0 5 per cent procaine are injected into, say, the buttock If nothing untoward happens, the epidural injection is given the next day.

DANGERS OF EPIDURAL INJECTION

These have been grossly exaggerated. Just as those who do not wish to learn how to manipulate harp on its dangers, so do those unwilling to learn how to insert a needle into the sacrum dilate on its unsuitability as an out-patient procedure. Provided the precautions outlined here are conscientiously

observed, little trouble is to be expected Three misfortunes have come my way i.e less than one for each 5 000 injections

One patient turned out to be hyper sensitive to procaine and became unconscious twenty minutes after the injection He had to be given artificial respiration for two hours until he came to none the worse for the severe reaction.

In two other cases, some numbness and weakness of the legs developed necessitating lying down for two hours after the injection A few hours later, after recovery from the anæsthesia, headache, nausea and stiffness of the neck came on, next day fever was present. Lumbar puncture showed 400 mgr of protein and 4 000 white cells per cubic mm Culture was sterile in each case.

A diagnosis of acute aseptic, possibly chemical, meningeal reaction was made, in a patient with undue permeability of the dura mater To be on the safe side, treatment with intra thecal penicillin was instituted and both patients got rapidly better, leaving hospital at the end of a week There were no sequelæ.

6 PROLONGED ANALGESIA

This measure is not often called for It can be used with advantage in almost any case of lumbago and, though with less effect, minor sciatica. Most patients, however are content to let their pain subside, even if this happens more slowly, rather than to accept admission for prolonged analgesia.

Indications

The chief indication is a large irreducible disc herniation at the fourth lumbar level causing lumbar symptoms. In the more extreme instances, the patient, though seldom suffering severe pain, is forced into a posture involving gross side-flexion deformity at the lumbar spine. The passage of time, rest in bed, manipulation and traction may have no effect. In such a case, the complete muscular relaxation induced by prolonged analgesia during recumbency may result in spontaneous reduction within a few hours

The other indication is not medical: the patient has important domestic reasons for wishing to be put right at once, but when manipulative reduction is attempted, it fails. Prolonged analgesia is therefore substituted.

Technique

The patient lies flat in bed in his position of ease. The anæsthetist administers either procaine by intravenous drip or pentothal and curare and keeps it up for four hours. During this time the patient is almost unconscious, feels no pain and his muscles relax completely. During relaxation, spontaneous reduction may take place. It is my practice, at the end of the third hour, to visit the patient and to change his posture in bed to the opposite of that in which he began his analgesia. His legs and pelvis are moved to the other side of the bed, so that his original lumbar curve becomes reversed The patient stays in hospital that night and is fit for discharge next morning. The treatment is in no way unpleasant and, properly carried out, free from danger. The patient merely recollects being in a dreamy state. However, the continuous attendance of the anæsthetist provides a real drawback, making this method too complicated for routine employment.

7. REST IN BED

Recumbency is the traditional treatment for both lumbago and sciatica; though tedious and time-consuming, it is nearly always effective in the end. It is a confession of failure, indicated when manipulation and sustained traction have failed and the pain continues to be severe. In lumbago and minor sciatica, reduction is slowly secured by the abolition of compression at the affected joint, whereas in major sciatica pain is eased during the early stage pending the start of spontaneous recovery. The more severe the symptoms—not the signs—the more is recumbency both called for and welcomed. In sciatica the pain may not begin to abate for the first two days and the patient may insist on getting out of bed to walk about the room. Though this may bring slight

temporary relief it postpones the initiation of reduction. Hence the patient should receive enough analgesics usually morphine, to keep him quietly resting for the first day or two As soon as he can, he must lie supine with a small pillow under his lumbar area and only one under his head. The pillow maintains his lordosis—that is, keeps the front of the joint as open as possible. Indeed the family doctor's best treatment for lumbago too acute for manipulation is probably the injection of a quarter of a grain of morphia and a cushion under the patient s back in bed This posture encourages the articular contents to move anteriorly away from the dura mater or nerve root. Patients with sciatica are kept in bed either until reduction is complete or until the pain has eased enough to make getting up only a discomfort. In the former case the patient lies flat until straight leg raising is of full range and painless. He then gets up for increasing periods, wearing his belt and maintaining his lordosis at all times If there is no return of pain or diminution in the range of straight leg raising, all is well, if the symptoms or signs begin to return another week in bed is ordered and the attempt to get up then resumed If a month or six weeks in bed are of no avail, laminectomy should be considered if the symptoms remain severe. In many patients, especially young adults, the pain largely ceases after some weeks in bed, but the range of straight leg raising hardly alters, persisting at, say 45° Such patients can get up—with the precautions mentioned above—and await spontaneous recovery Patients must not be kept in bed until the signs of loss of conduction have receded, for these continue for many months after all pressure on the nerve-root has been released Sometimes the muscles controlling the foot never regain their full power the ankle-jerk is often permanently lost.

Young and middle-aged patients, not necessarily in severe pain, who are found to have developed marked weakness of the muscles in the leg within a few days of the onset of sciatica, should be put to bed at once. If this is done, the muscular paresis may recede within a few weeks, if not, it may take a year for strength to return This applies only if the patient is seen within a week of the onset rest in bed begun some weeks after the weakness is well established

comes too late to save conduction. In the elderly, muscle weakness is less important and can often be ignored. After the age of sixty recumbency has inconstant results; for osteophyte formation and capsular contracture then often combine to prevent the vertebral bodies moving apart when the compression force of weight-bearing is abolished. Hence, determined efforts at manipulative reduction should be made in elderly patients before recumbency—with its attendant hypostatic dangers—is decided upon, the more so since pulpy protrusions are rare after the age of sixty. The warm regard for lay manipulators expressed by some members of the House of Lords at the enquiry into osteopathy in 1935 was based on the fact that many obscure pains felt by elderly persons can be abolished only by manipulation of the spinal joints; other measures usually fail.

Rest in bed for lumbago should cease when the patient finds he can get up without return of symptoms.

8. AWAITING SPONTANEOUS RECOVERY

STRETCHED ROOT AND VERTEBRAL EROSION

Backache shows little tendency to spontaneous cure except in the very long run. Between the ages of fifty and sixty, the spinal joints tend to lose their range of movement owing to capsular contracture; moreover at this age osteophytes, both cupping the disc and further limiting articular movements, make their welcome appearance. Hence intermittent backache or attacks of lumbago often cease at this time of life. The position is quite different in sciatica (except in the elderly. A pulpy protrusion causing root-pressure at the third lumbar level usually ceases to cause symptoms after six to eight months and at the fourth or fifth lumbar level after a year. Muscular weakness unless extreme nearly always recovers and the range of the movement that stretches the nerve-root regains full range. Only the appropriate reflex is apt to remain permanently abolished. The younger the patient, the more sure eventual recovery is; for the protrusion is large, irreducible, presses constantly at the same point and is jolted against the bone at each heart-beat by its contact

with the pulsating dura mater It takes a year for the root to stretch or protrusion to form a cavity in the bone and nest itself into it (see Fig 64) A patient who has recovered in this way is, in my view, no more liable to further attacks of disc-protrusion than any other individual, for two reasons. First, his protrusion has been accommodated in a position whence redisplacement is impossible. Secondly, a certain amount of nucleus pulposus has left the joint permanently, with consequent reduction in the intra articular pressure

This is an important point. A patient in his twenties or thirties may be seen who has had sciatica for say, four months He is in constant discomfort but has had no real pain since he spent some weeks in bed at the onset. The symptoms often amount to only an ache the patient has a cheerful demeanour and sleeps well Examination shows little or no lumbar deformity marked limitation of straight leg raising (80–45° range) on the affected side, and slight evidence of impaired conduction, *e.g* some weakness of, say the extensor hallucis muscle or sluggishness of the ankle jerk. If the position is explained to him, he may well prefer to put up with his slowly diminishing symptoms for another eight months in the knowledge that he will then be unlikely to suffer recurrence, rather than accept a quick recovery from sustained traction with its restoration of the *status quo* and consequent possible recurrences When the patient understands the likely course of his malady and the results of treatment he becomes a responsible party to the decision eventually arrived at. If he agrees to wait, he is seen at one or two monthly intervals until he is almost well. Unless exceptional domestic reasons exist, spontaneous recovery should always be awaited after six months' root pain. When the discomfort in the lower limb is still considerable a compromise can sometimes be reached. Sustained traction is continued until the pain has largely eased but the range of straight leg raising has not yet begun to increase. Treatment then ceases. Such a slight degree of reduction will be found not to interfere with eventual spontaneous recovery

About one case in forty fails to respond to the passage of time in the expected way If a young patient's minor symptoms and major signs have not abated after fourteen to sixteen months, and epidural local anæsthesia proves

ineffective, and the inconvenience warrants, laminectomy is indicated. It is a common fault today to submit these patients to laminectomy three or four months after the onset on the grounds of lack of progress. Since operation carries with it a cure rate in the region of 70 per cent and disables a patient permanently from heavy work, whereas the passage of time leads to 97 per cent recoveries and restores the capacity for heavy work, it is most important that nothing should be done too soon. Laminectomy carries with it a further important disadvantage: the mechanism of spontaneous cure is interfered with and, should the operation fail, the patient is apt to remain in pain for many years afterwards. Yet he would have got well had nothing been done.

After the age of sixty, spontaneous recovery may not occur, partly because the protrusion is usually so small and partly because sclerosis is often found at the bony margins of the affected joint.

PRESSURE ATROPHY

Spontaneous disappearance of pain can be effected in another way. It is much less common than stretching or erosion and takes only some days to appear. A patient who has been suffering considerable pain in the limb may state that the foot went numb but his pain eased in the course of some days. Examination shows that, as the pain diminishes and the range of straight-leg raising increases, the muscles controlling the foot become progressively weaker and the skin increasingly insensitive. This event is usually manifest during the first week or two after a sciatic pain has begun. The existence of this phenomenon makes it important to contrast the degree of straight-leg raising with the strength of the muscles in the leg in any patient who states that the pain in his limb is suddenly becoming much less severe. A fair-sized protrusion may cause intense pain, because the sensitive nerve-root is severely pinched. A further increase in size may abolish pain and restore a full range of straight-leg raising by rendering the nerve-root wholly insensitive, doubtless from ischaemia. Pressure so great must also interfere with conduction too; signs of gross parenchymatous damage therefore appear.

In such a case, if it is seen early on, the patient must either accept a weak foot for a year or even permanently or have an immediate laminectomy If he is first encountered after some months, no treatment avails, for, operation or no operation, the power in his foot will now take many months to return and even successful laminectomy scarcely hastens eventual recovery

Unless the circumstances are exceptional, *e.g* the patient is an athlete, all treatment, including operation, is best avoided in these cases

9 LAMINECTOMY

This must not be undertaken lightly, but should not, on the other hand, be unreasonably withheld The addition in 1950 of sustained traction to the resources available for dealing with lumbar disc lesions reduced my laminectomy rate from one in forty to one in two hundred If laminectomy is to be performed, every effort must be made to secure the services of a surgeon amply experienced in this particular operation Even in the best hands the results in sciatica are not perfect immediate relief is secured in about 80 per cent of patients but recurrences bring this figure down to 70 per cent within five years This tendency to recurrence—which may of course result from disc-displacement at another level—should be regarded as barring patients from resuming heavy work after laminectomy Hence, let us say, the farmer suffering from recurrent attacks of disc displacement, who wishes for operation in order to have restored to him his capacity for heavy labour, is asking for what may prove an impossible achievement and must be told so

Laminectomy in the presence of lumbar symptoms alone carries only half the cure-rate obtained when root pain is present. Hence it is my practice, if there is nothing for it but operation in such cases, to ask the patient for instance to dig until he brings sciatica on and to be operated on only at a time when straight leg raising is unilaterally limited

Twelve per cent of patients have been found at laminectomy (R. H. Young) to possess herniation at two levels.

INDICATIONS

1. *Severe Intractable Pain*

When a sufficient trial of adequate conservative treatment fails to bring relief, laminectomy is indicated, if the pain remains severe. If not, spontaneous cure should be awaited. Lasting pain may mean that part of the annulus has worn through the capsule of the intervertebral joint postero-laterally, coming to lie with one end free inside the neural canal. In such a case conservative treatment, however prolonged, is bound to fail. It is also possible for pulp to escape past an intact annulus and then, as the joint space in consequence narrows, become trapped by contact between annulus and vertebral body. The path whereby reduction could take place is thus obliterated. Alternatively, the end-plate may buckle and finally double over on itself; a lesion clearly susceptible only to surgical treatment.

The worse the symptoms and signs, the better the results of the operation. A history of previous attacks also augurs well, for it implies that the lesion is as mature as possible. In particular, by operating late, ample opportunity has been given for protrusion at both levels to develop. If so, both discs are dealt with at once and the likelihood of recurrence is correspondingly diminished.

Care must be taken to be sure that the physical signs confirm the allegations of severe pain. A multiplicity of test movements is employed, if necessary, and patients' sincerity assessed objectively as well as by the ordinary summing up of patients' character.

2. *Gross Lumbar Deformity*

When a young patient, especially a woman, develops a gross side-flexion deformity as the result of a fourth lumbar disc-displacement, the deformity becomes permanent if it is allowed to persist for some months. Hence, operation may be indicated to avoid disfigurement.

Sciatica with marked lumbar side-flexion deformity more often comes to laminectomy than when the spine is held symmetrically.

3 *Incipient Drop foot*

A patient who develops increasingly pronounced weakness of the muscles controlling the foot must be warned, so that he may choose between immediate laminectomy and the possibility of a permanent weak foot. In such cases pressure atrophy may cause complete insensitivity of the nerve-root, as a result, pain is abolished and straight leg raising quickly reaches full range at the same time as the palsy becomes complete The patient, concerned as he has been with his pain, is apt mistakenly to believe himself to be improving, but the physician must explain the true position to him

4 *Bladder Weakness*

Since incontinence of urine is apt to result from pressure on the fourth sacral root and to become permanent unless relieved at once, laminectomy should be performed early in these rare cases (see p 426)

5 *Adherent Root*

If the symptoms warrant, the adhesions must be divided at laminectomy There is no alternative.

6 *Buckled End Plate*

When the patient is asked to bend backwards, he is quite unable and, when he tries, squeezes the cartilaginous block at the back of the joint and is seen to recoil forwards again in a manner suggesting the springy block of a meniscal displacement at the knee. Only laminectomy discloses the state of affairs and there is no other cure.

7 *Repeated Crippling Attacks*

These may occur so often and be so severe while they last that the patient's life is made a misery Even if reduction is easily achieved, whether spontaneously or as the result of treatment, another attack follows in spite of adequate precautions for the maintenance of reduction.

In such cases both laminectomy and arthrodesis are effective. If the former alternative is decided upon, it is important that the operation should be carried out at a time when maximum displacement is present, even if this has to be purposely induced just before the operation.

CONTRA-INDICATION TO LAMINECTOMY

It is not so much the severity of the lesion but rather the amount of pain experienced that provides the main indication for laminectomy. Moreover, the criterion of cure is largely the patient's own statement afterwards. It is thus essential to provide the surgeon with co-operative patients. Individual sensitivity to pain is gauged in two ways. First by the assessment of personality afforded by listening carefully to the patient's account of his troubles, together with his disgressions. Secondly by testing a number of movements and noting the responses when irrelevant as well as relevant movements are performed. Since minor symptoms due to low lumbar disc-lesions are all but universal, it is not difficult for a patient credibly to describe and to exaggerate backache or sciatica, severe disablement being alleged for the purposes of obtaining compensation, getting a permanent pension or escaping from some domestic situation Such symptoms often appear confirmed when a narrow disc-space is visible on the radiograph These patients may welcome operation and, once it has been performed, it becomes all but impossible to be sure whether a patient's pains are of organic origin or not.

It must be remembered that, when a complaint of backache or sciatica is made, it is seldom wholly groundless. Some discomfort may well exist and careful examination may disclose signs of a past or present organic disorder. Purely psychogenic symptoms are easily detected, a slight organic disorder complicated by a large psychogenic overlay proves more difficult to sort out accurately into its two components. Prolonged disability after operation is to be expected if such patients are operated on, even if such organic trouble as was found was adequately dealt with. After all, any laminectomy, however successful, may be followed by some intermittent backache. Ordinary patients are so vastly improved

that they ignore this slight symptom, but it is grasped at gladly by the psychoneurotic. Unrecognized psychoneurosis is becoming, in my experience, increasingly treated by measures designed to affect a disc lesion, especially manipulation, immobilization and laminectomy Hence the operation should be avoided if the patient's character precludes the achievement of a good result.

It is most important that the protrusion should be as large as possible at the time of laminectomy Thus, if reduction has taken place while the patient awaits operation, this should be postponed until, by design or accident, protrusion recurs At the time of the operation, the more marked the lumbar signs and the limitation of straight leg raising the better

Though the centrifugal force acting within the joint has been greatly reduced by removal of the whole nucleus, recurrence at the same joint is a real danger Hence the patient should never return to heavy work. If he decides to do so against advice, he must be warned of the risk that he runs He should wear a corset for a year after the operation

10 ARTHRODESIS

By comparison with laminectomy spinal grafting is a minor operation for it is performed outside the spine without removing bone or exposing dura mater or nerve-roots An incision is made, the muscles on each side are separated from bone down to the bases of the spinous processes where periosteum is stripped up locally Two grafts are laid in place and secured here It is the fact that the patient has to await fusion by lying for two months on a plaster bed and then remaining immobilized in plaster for three further months that gives the operation its formidable character After fusion at one joint, many patients can still bend down to reach their ankles.

The indications are (1) Spondylolisthesis causing capsular lumbar pain or bilateral sciatica. (2) Anterior protrusion (the mushroom phenomenon) (3) Unsuccessful laminectomy (4) Intractable severe backache. Since laminectomy is often a failure when a disc-lesion causes only lumbar pain,

arthrodesis may be preferred as a first rather than a second resort.

One important point must be observed before spinal fusion is undertaken—namely, that no displacement exists at the time when the operation is performed. This precaution is sometimes neglected, especially in spondylolisthesis with a secondary disc-lesion, with the result that later the graft has to be removed and laminectomy carried out

PREVENTION OF RECURRENCE

Once the fragment of disc is back in place, or has been removed at laminectomy, the question of preventing recurrence arises.

ADVICE TO THE PATIENT

The mechanics of lumbar disc-protrusion must be explained to the patient, who often imagines that septic foci, choice of food or underclothing, or damp working conditions affect his back. He must be told that so long as his lumbar spine is held in lordosis the joint tilts so that the front is more widely open than the back; in this position movement backwards of the loose part of the disc is virtually impossible (see Figs. 58 and 59). He must be shown how to stand, sit, bend, and lift, using his knees rather than his back. Neurosis is prevented by explaining that the disorder is purely mechanical, and not the precursor of a crippling disease capable of spreading to other parts of the body. With some exceptions he can go on doing whatever he did before; it is merely the way of doing it that has to be changed.

SUPPORT

A Plaster Jacket

This is a method in great vogue at the moment, but I believe it is seldom worth the discomfort it entails. It is usually employed wrongly—that is, in the hope of securing reduction rather than of maintaining it. It is a mistaken

policy to put a patient with an annular protrusion into plaster, for I have reduced such displacements by one manipulation after as long as six months' vain immobilization. By contrast, pulpy herniations do sometimes reduce themselves slowly in plaster but these are the simple ones that do so much more quickly when treated by sustained traction or recumbency Plaster acquires a spurious reputation when a patient with sciatica, who will get well of himself in the course of say, eight months, is kept in plaster until he has all but recovered He has in fact had a rather more uncomfortable time of it than was necessary, but naturally attributes his relief to the treatment imposed One untenable reason for immobilization has been expressed (Crisp 1948) that rest in plaster allows the broken cartilage to unite Intra articular cartilage has no blood supply, therefore it cannot heal at a spinal joint any more than at the knee-joint. Thirty years ago immobilization of an internally deranged knee was still practised in the hope that the fracture in the meniscus would unite. This idea is long since obsolete, but the same mistake is now being repeated at the lumbar joints

The real indication for a plaster jacket is—as for a fracture—the maintenance of reduction. If reduction proves unstable, support must be supplied at once. A plaster jacket may thus be worn for a few days until a more suitable appliance is ready Since a plaster cannot be made really tight and weighs twelve to twenty pounds, it should be abandoned as soon as the alternative is to hand

A Plastic Jacket

This is far more effective than any plaster jacket and weighs only three to four pounds (see Fig 50) It takes only two days to make. It can be taken off at night and can be tightened to any fit required, thus allowing changes in volume after meals For any of the purposes to which a plaster jacket is put today a perforated plastic corset is better It is pleasanter, lighter, cleaner, more hygienic and can be worn for months or years if necessary without renewal or getting out of shape.

A Corset

As a rule, neither a plaster nor a plastic jacket is needed. In the ordinary case a surgical corset made of cloth with two posterior steels answers the purpose excellently. Whereas a plaster jacket cannot be worn for longer than some months, and thus cannot provide lasting protection against recurrence, corsets, renewed each year or two, can be worn indefinitely, thus affording permanent security. If the two steels are accurately moulded to the lumbar curve, lordosis is maintained and the joints steadied. Moreover, if the patient bends too far forwards or sags as he sits, the front of the corset presses unpleasantly against his lower ribs—a salutary reminder

The increased prescription of surgical corsets since the place of disc-lesions in the ætiology of backache became recognized has led to much second-rate work. The essential points about a corset intended to support the lower lumbar spine are:

1. *Stiffness.* There must be two posterior steels accurately moulded to the sides of the sacrum and the lumbar lordosis, and their tendency must be to hold the thorax slightly backwards; they must on no account press it forwards. If the curve of the steels is less than that of the patient's lordosis as he stands upright, the effect is to force the thorax forwards—the very posture the corset ought to prevent. This is a common failing, making an otherwise acceptable corset worse than useless. The anterior whalebones must reach high enough to engage against the patient's lower ribs if he bends forwards too far. They must not indent the abdominal wall just under the ribs, as they will if too short, or their ends will rub holes in the skin. A stiffener must not lie directly against the anterior superior spine of the ilium; it must pass medial or lateral to this bony projection. Some patients prefer anterior steels

2. *Balance.* The centre of the posterior aspect of the corset must lie at the level of the lesion. Clearly the extent of corset above and below the point requiring support must be the same.

Contra-indications to Corsetry. A corset is useless in lesions caused by compression, *e.g.* the mushroom phenomenon. It

stabilizes the lumbar joints but cannot alter the compression of weight bearing A corset is contra indicated in lumbar disc-lesions secondary to unilateral osteo-arthritis of the hip-joint. As he walks, the patient, since he cannot extend at the hip has to bring his thigh backwards by extension at his lumbar joints Such excessive use leads to hypermobility and later on, to a low lumbar disc-lesion If an attempt is made to control this by a corset, it is secured only at the expense of further hindrance to walking

DISC LESIONS IN THE ELDERLY

After the age of sixty most disc lesions are small and cartilaginous therefore they are nearly always reducible by manipulation. Moreover they lie within joints at which movement, and therefore distraction, is very limited by osteophyte formation and capsular contracture Hence several months in bed and traction prove equally ineffective for neither method achieves enough separation of the joint surfaces to let the displaced fragment slip back. Owing partly to the small size of the fragment of annulus and partly to sclerosis of bone at the joint margins, the young person's mechanism for spontaneous cure does not operate hence not only backache but also sciatica can go on indefinitely

The history is distinctive in sciatica for the backache does not cease when the root pain comes on Examination shows some of the lumbar movements to elicit the backache in the expected way trunk flexion is seldom limited and may not set up pain in the limb Straight leg raising is seldom limited and may not even evoke the pain in the limb Muscular weakness is uncommon and the ankle-jerk is apt to become sluggish only after many months

In cases of this type, the orthopaedic physician's hand is forced However unwilling he may be, however old and frail the patient, however fearful both may be, the choice lies between leaving the patient in pain, perhaps for life, and manipulation When the situation has been explained to the patient and his doctor, if they agree, manipulation must be attempted with adequate care but also enough firmness to give the patient a chance.

Manipulative technique should be restricted to the prone-

lying extension pressure; for applying a rotation strain using the femur as a lever might easily fracture the femoral neck.

DISC-LESIONS IN PREGNANCY

Some women make room for the enlarging uterus by bending forwards over it, losing their lumbar lordosis. Others counterbalance the forward shift of their centre of gravity by bending backwards, increasing their lordosis. The former alteration in posture may result in backache. By contrast,

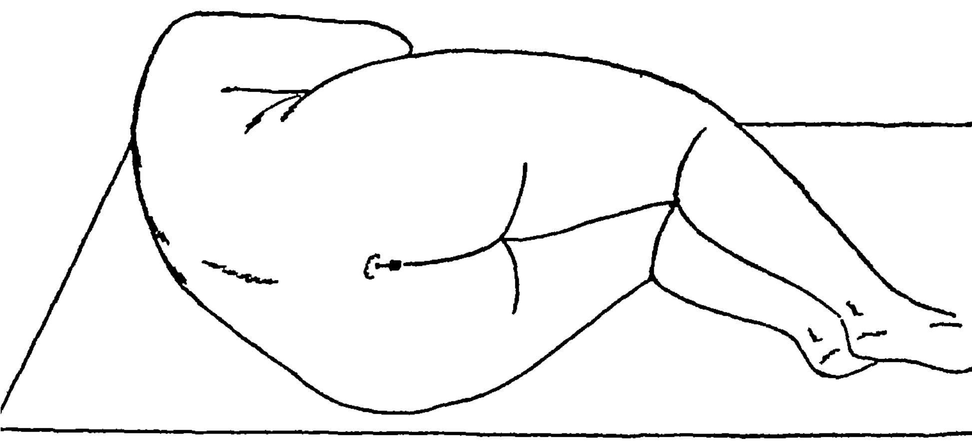


FIG 90—Position of patient for induction of epidural local anæsthesia during advanced pregnancy The patient lies on the affected side

those women with low lumbar disc-lesions who adopt extension are more comfortable when pregnant than at any other time.

A young woman with a lumbar disc-lesion can be assured that pregnancy will not harm her back and that labour itself will not be affected. An expanding lumbar corset may be prescribed. She should, however, be warned that her posture in bed during the puerperium determines whether or not her disc-lesion becomes more severe. Obstetrician and nurses should be apprised of the state of her back so that proper support for her lordosis is forthcoming throughout the period of rest in bed (see Figs. 56 and 57). She should turn to lie prone for several periods each day as soon as her condition permits.

During the first three months of pregnancy a disc-lesion can be treated by manipulation or traction in the same way as if the woman were not pregnant. During the second trimester, traction and the prone-lying manipulations cannot be employed, but side-lying and supine rotations are still practicable. During the last three months, epidural local anæsthesia remains quite safe and is often effective The injection must be given with the patient lying on her side (see Fig 90) Since the fluid injected tends to gravitate downwards (see Plate 25), she must lie on the affected side during the induction

If the epidural injection fails rest in bed is indicated

DISC-LESIONS IN ADOLESCENTS

Disc-lesions are uncommon in children and are scarcely encountered at all before the age of ten During the early teens they are rare, but begin then to appear both at thoracic and lumbar levels At both sites, immediate manipulative reduction is called for and usually has the happiest results The fact that growth still continues enables adjustments to be made spontaneously, hence many of my schoolboy patients have returned to games within a few days and have continued athletics for their university years without a recurrence By contrast, manipulative reduction may require many repetitions if wedging caused by adolescent osteochondritis is a causative factor

Sciatica with limited straight leg raising and say, an absent ankle-jerk begins at twelve years old Treatment is contra indicated since the pain is slight. The teenager should not play games and be kept under observation until well this usually takes six to nine months whereupon he can forget the whole incident and return to all normal pastimes Epidural local anæsthesia may be required if recovery appears delayed and I have used it from the age of fifteen and upwards Operation is nearly always avoidable My youngest to date was seventeen and was found to have two huge protrusions at the operation, at the fourth and fifth levels

There is a central persistent backache in adolescents that goes on for years. Straight leg raising is bilaterally limited,

there are no other signs. It can be shown by epidural local anæsthesia (which abolishes the pain and restores the range of straight-leg raising for about two hours) to be the result of a low lumbar disc-lesion. The only non-operative treatment at all likely to succeed is sustained traction; moreover the symptoms are not severe enough to warrant operation. The pain can go on for years unaltered; for, since the protrusion is central, not postero-lateral, no period can be assigned to spontaneous recovery. Hence traction must be given daily until the patient is well—often one, two, even three months. Since nothing else avails, persistence is essential even if no improvement is apparent during the first few weeks.

DISC-LESIONS AND SPORT

The emphasis throughout is on the fact that the patient can do what he did before, but must do it differently. He must flex his knees rather than his lumbar spine.

Swimming is the only actively beneficial sport. While in the water, the swimmer keeps his trunk extended in order to raise his head to breathe; moreover he is suspended in a fluid medium and all compression on the lumbar spinal joints ceases. Diving is dangerous, since patients liable to lumbago have been known not only to become fixed in flexion in mid-air, but also to experience great difficulty in reaching land again.

Tennis can be permitted to patients with pulpy herniations for the quick movements of down and up do not allow enough time for the nucleus to ooze Patients with an annular fragment, on the other hand, play at their own risk.

Riding is harmless as long as the patient does not tire. While he is fresh, he maintains his lordosis—the correct posture for riding. If he continues to the point of fatigue, he may slump, thus losing his lordosis. Hence he *must* work up to a day's hunting by degrees.

A schoolboy can usually play rugger if he is kept out of the scrum.

OBSOLESCENT TREATMENTS

Two measures have been universally employed in the treatment of backache in spite of their manifest lack of success. They are mobilization under anæsthesia and postural exercises

MOBILIZATION UNDER ANÆSTHESIA

The justification for this method of treatment rests on a misapprehension of the lesion present. Mobilization under anæsthesia—*i.e.* putting the joint through its full range of movement during complete muscular relaxation—is suited to rupturing adhesions. But in backache and sciatica no adhesions are present, a displacement exists requiring reduction. Admittedly it can be reduced under anæsthesia, but only with difficulties and dangers that are avoided if the patient remains conscious. It is not a set manipulation what to do next depends on what effect previous steps have had. Deprived by anæsthesia of the patient's active co-operation, the manipulator has no idea whether to go on or stop, whether to repeat a manipulation or to avoid it. Moreover, should incontinence result from the manipulation (as has happened) as the result of pressure on the fourth sacral root, the manipulator under anæsthesia would be most awkwardly placed if he then had to show that every care had been taken to avoid this rare complication Another hazard under anæsthesia is death from rupture of an arterio-sclerotic aorta during forced hyperextension

Even more barbarous is forcing a full range of straight leg raising under anæsthesia. Whereas lumbar manipulation under anæsthesia, however haphazard can secure reduction, to treat the limb for a lesion in the back has no logic in it. The only way benefit appears to follow "stretching the sciatic nerve" is when the root is so tautened over the projection that an immediate pressure palsy results Patients are encountered who lost their pain but developed a weak numb foot from the moment of this manipulation they form a moderately pleased minority

POSTURAL EXERCISES

There must be very few doctors who do not consider postural exercises an excellent remedy for backache. This belief is so ingrained that they dismiss as fanciful or prompted by laziness patients' complaints that the exercises make the backache worse. Nevertheless, the patients are right. Postural exercises are harmful in backache; they are suited only to children with postural deformity without backache. Even then they are of doubtful effectiveness. There is all the difference in the world between teaching the patient to hold a certain posture and giving postural exercises. If a joint subject to internal derangement is exercised, it is moved to its extremes of range; as a result mobility is maintained and with it the liability to intra-articular displacements. If a joint is kept still in a position unfavourable to the development of internal derangement, obvious benefit follows. Postural instruction, yes; postural exercises, no.

FUTURE TREATMENTS

Suggestions, not altogether fanciful, follow:

A NEW DISC

The restoration of the disc and its space is not a theoretical impossibility. A plastic substance in solution could be injected into the affected joint while traction kept the vertebral bodies apart. This would then set, enclosing the fragments of disc, during the time that the tautened capsule of the joint exerted centripetal force. The disc would then become one solid mass again, the hitherto loose pieces lying embedded in the plastic material. Alternatively, the nucleus pulposus could be aspirated and intra-articular centrifugal force thus abolished. But so wide a bore to the needle would be required that this is scarcely practicable

CHEMICAL ARTHRODESIS

An alternative is chemically induced arthrodesis. If a substance were discovered that promotes the formation of new bone and were introduced into the intervertebral joint,

permanent fixation would be achieved without operation. Since capsular ossification occurs after bacterial arthritis, in spondylitis deformans and in fluorine poisoning stimuli with this effect clearly exist. Animal experiments on the effect on joints of injection of various concentrations of fluorides in solution might well prove the starting point for discovering a safe method suited to human joints

SIMPLIFIED ARTHRODESIS

In the meanwhile, simplified techniques of arthrodesis not requiring appreciable post-operative rest in bed ought to be investigated. The adjacent surfaces of two spinous processes might be stripped of periosteum and the interspinous ligament excised A wedge of bone could then be introduced between the spinous processes The two spinous processes would now be tightly wired together squeezing the graft. The patient should be allowed up in a plastic corset within a few days. I find it difficult to believe that an operation on these lines could not be made a success and remove the important disadvantage from arthrodesis the long immobilization afterwards. Debeyre's anterior arthrodesis by the abdominal approach necessitates only a month in bed

A LASTING ANÆSTHETIC AGENT

Epidural local anæsthesia destroys backache due to a disc protrusion for an hour or two, then the pain often returns If a local anæsthetic agent could be devised that lasted for several weeks, it would be well worth while for those patients who have an intractable constant backache due to a minor disc-lesion to attend at, say, monthly intervals for repeated epidural injections. It is very galling that, though a remedy for chronic backache exists in theory, the agent appears no closer to discovery than at the turn of the century

OTHER LUMBAR DISORDERS

These are treated on standard lines.

Simple Wedge fracture

Contrary to general belief uncomplicated wedge-fracture

of a vertebral body does not require immobilization in plaster. Indeed, many such fractures are discovered years later on a radiograph taken for some other reason.

A fortnight in bed, during which prone-lying trunk-extension exercises are prescribed, suffices. The patient must not, of course, lie with pillows in flexion. For a further month, he is up and about, but is not allowed to bend forwards. At the end of three months the fracture is consolidated. After that, whatever the vertebral body may look like on the radiograph, the presence or absence of symptoms depends on what has happened to the adjacent discs and to the patient's state of mind.

Fracture-dislocation is an entirely different matter. The spinal cord and cauda equina are in grave danger and surgery is usually required.

Fractured Transverse Process

Fracture of one or more transverse processes is in itself an unimportant injury, since spontaneous recovery without treatment takes at most a fortnight. Whether eventual union by fibrous tissue or by bone takes place has no significance. If the patient is anxious for exceptionally speedy recovery, he can be got well in less than a week by local anæsthesia induced between the bone ends, then deep massage to the lateral aspect of the sacrospinalis muscle in the vicinity of the transverse process, followed by gentle exercises Rest in bed, plaster and so on are all contra-indicated.

Force sufficient to break bone may damage the disc. Hence pain persisting longer than two weeks almost certainly arises from a lesion other than the fracture visible on the radiograph. A fractured transverse process is really a muscle-injury; it gives rise to muscle-signs and strictly unilateral pain. Hence the distinction becomes clear if, as should always be done, the joints and muscles are tested separately.

Adolescent Osteochondritis

If this causes symptoms, these appear due to a disc-lesion secondary to the kyphosis at the affected joint that results from the wedging. Manipulative reduction should be carried out as required.

The wedging never becomes extreme and orthopædic measures are not required.

Senile Osteoporosis

This does not of itself cause symptoms and care must be taken that elderly women with a disc-lesion complicating symptomless osteoporosis are not regarded as suffering from the condition shown on the radiograph If pathological fracture results, this causes bone pain for up to three months

In my experience testosterone and huge doses of vitamin D do not arrest the bone disorder, which is believed to have an endocrine basis.

Spondylolisthesis

If this causes capsular lumbar pain or bilateral sciatica, arthrodesis is required unless a corset affords adequate relief A secondary disc-lesion is treated on standard lines, dis regarding the spondylolisthesis.

Chronic Osteomyelitis

Immobilization on a plaster bed is instituted at once and maintained until ankylosis is well advanced This usually takes three or four months from the time that it becomes possible to make the diagnosis Suitable antibiotics are naturally administered, but it is difficult to know when they can be safely stopped since the patient may remain afebrile throughout.

Osteitis Deformans

No known treatment has any effect on the disease as such, but if only one vertebra has collapsed and is causing symptoms, arthrodesis locally prevents increased pain and deformity Butazolidine is often helpful.

Anterior Longitudinal Ligament

Since this suffers when the abdominal and sacrospinalis

times there is no pain in the buttock at all. Since a disc-lesion compressing the first sacral root may also give rise to pain felt throughout the first sacral segment, the root-pain is indistinguishable in character and outline from a first-sacral pain originating at the sacro-iliac joint. The position of ten years ago has been reversed. Then disc-lesions were normally ascribed to sacro-iliac strain; nowadays sciatica caused by a lesion of the sacro-iliac joint is nearly always ascribed to a disc-protrusion. This is a great improvement, since disc-lesions are by far the more frequent, but the error is quite unnecessary, since clinical examination quickly reveals whether the lesion lies at the lumbar spine or at the sacro-iliac joint.

HISTORY

Men

Only one painful non-specific disorder of the sacro-iliac joint exists in men—the sacro-iliac arthritis that ushers in spondylitis deformans (ankylopoetica).

The patient is aged between sixteen and forty and states that he has had an ache in *one* buttock and/or thigh for a time. He may have had one or two previous attacks during the previous five years, lasting some months. When the patient is questioned how the pain came on, he states that there was no strain or accident, that the pain comes and eases irrespective of activity and is *not* aggravated by exertion. If the ache is severe, a cough hurts in the buttock. The pain lasts some months as a rule—then ceases; then returns. Later it may appear in the other buttock or thigh; very seldom, and then only for some days, is bilateral pain noted at the changeover. A complaint of alternating sciatica or of pain first in one buttock and later in the other strongly suggests the flare and wane in alternate sacro-iliac joints that heralds spondylitis deformans. Some time after these sciatic pains have finally ceased, central lumbar aching begins. Once the lumbar region has become affected, further pain arising from the sacro-iliac joints is uncommon. Loss of weight, amounting at times to one or two stone, may be mentioned and the patient feels vaguely unwell in an

unexplained manner that often leads to a diagnosis of psychoneurosis

Spondylitis may evolve painlessly, the patient noticing merely that he has a stiff back, and paying no attention. What brings such patients first to hospital may then be inability to turn the neck or stiffness in the hips. In other cases, infective arthritis of knee, shoulder or tarsus may be the first sign, rarely iritis is the presenting disorder

Women

Two painful non specific disorders exist at the sacro-iliac joint in women, sacro-iliac arthritis and sacro-iliac strain When women develop sacro-iliac arthritis, the history is identical with that in men (see above), but only one patient in eight with spondylitis deformans is a woman The disorder evolves more slowly and, if it starts in a patient's late twenties, may even remain confined to these joints for many years Until 1955 I had never seen a patient who started spondylitic sacro-iliac arthritis after the age of forty That year I saw a woman of forty-seven who had had three years' alternating sciatica. Clinical examination showed the sacro iliac joints responsible and radiography afforded clear confirmation

Sacro-iliac strain is the other possibility It would have been a great pleasure to me if sacro-iliac strain had proved a myth, this would have been a neat situation It certainly does not occur in men, of that I have convinced myself by careful clinical examination of more than ten thousand male patients. In women, however, though it is found present only once in five hundred cases of low backache, the clinical signs have compelled me to make this diagnosis, try to avoid it as I might.

Sacro-iliac strain occurs in women aged fifteen to thirty five, it is always unilateral and gives rise to pain felt in the buttock only It may be associated with pregnancy but just as often is not. The ache is increased by exertion, eased by rest a cough may hurt. The resemblance to the symptoms of a low lumbar disc lesion is complete.

EXAMINATION

In sacro-iliac arthritis inspection seldom reveals the peaky faces and sunken eyes that characterize the later stages. Indeed, the patient is often a healthy young man, who has not yet begun to notice any of the constitutional effects. In severe arthritis there is occasionally such pain on walking that the patient shuffles in with the aid of two sticks.

The finding that directs immediate attention to the sacro-iliac joint as a possible cause of pain in the buttock and/or thigh is the unusual discovery that no lumbar movement affects the gluteal symptoms. Rarely, in acute arthritis, the lumbar movements do affect the pain, since at the extreme of any lumbar movement, added stress falls on the sacro-iliac ligaments. This does not confuse; for, if such an indirect strain on the joints hurts, more severe pain is set up as soon as the sacro-iliac joints are directly tested.

In sacro-iliac strain inspection reveals nothing abnormal. The woman looks and feels well and the lumbar movements are found not to affect the pain in the buttock. The range of movement at the lumbar spine may be greater than usual.

Testing the Sacro-iliac Joint

Three methods exist whereby tension can be exerted on the sacro-iliac ligaments without affecting the lumbar spine. These are set out below:

1. *Stretching the Anterior Sacro-iliac Ligaments.* The patient lies on his back on a soft couch. If the couch is hard, the sacrum is pressed against an unyielding surface. This may then hurt centrally, over the sacral spinous processes, not to one side of the sacrum. The response to this test is positive *only if it is stated to evoke unilateral gluteal or posterior crural pain.* When spondylitis deformans is more advanced and reaches the lumbar spine, testing the sacro-iliac joints ceases to hurt. In, say, acute lumbago, this test is sure to appear positive; for the slightest movement transmitted to the lumbar spinal joints must prove most painful; hence the support of a cushion or of the patient's forearm under the back may be required to stabilize



PLATE 20

Lumbar myelogram. Spinal tumour at the fourth lumbar level The patient had had nine months pain in the right groin and six months sciatica. Straight leg raising was limited on the right no alteration of muscle power or reflex was detectable, but the patient's flexed posture aroused immediate suspicion.



PLATE 30

Traction on lumbar spine Two photographs have been superimposed, corresponding at the sacrum and iliac crests The first was taken as the subject lay prone, the second after ten minutes' traction by 100 lb The amount of distraction obtained is visible and can be seen to be less than that secured so easily at the cervical spinal joints (see Plate 6)

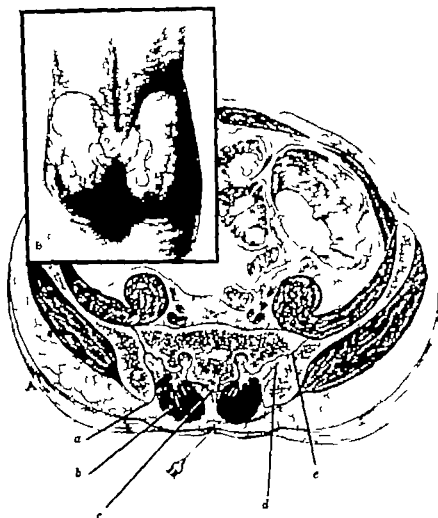


PLATE 31

Relations of sacro-iliac joint. Note the impossibility of eliciting tenderness of the posterior ligament by digital pressure

(*a*) Posterior superior spine (*b*) sacrospinalis muscle (*c*) spinous process of first sacral vertebra, (*d*) interosseous sacro-iliac ligament (*e*) sacro-iliac joint. (From *J Bone Jt Surg.*, 1938)

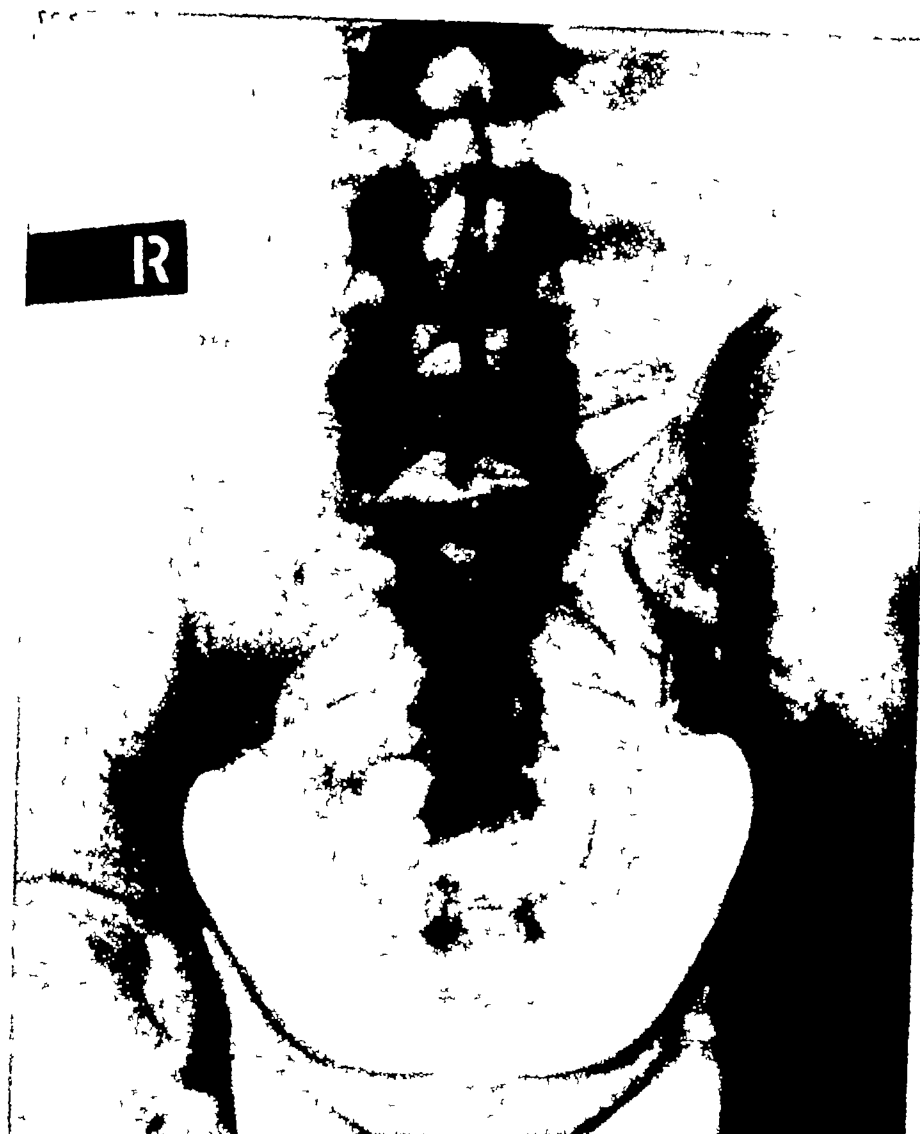


PLATE 32

Early spondylitis deformans Sclerosis at the iliac side of the lower part of the left sacro-iliac joint is beginning The patient was aged 19 and had had bouts of pain in one or other buttock for a year and a half Previous radiographs had revealed nothing



PLATE 33

Sacro-iliac fusion. The sacro-iliac joints have disappeared as the result of spondylitis deformans of thirty years standing Note the ossification at the left side of the second lumbar vertebra.



PLATE 34
Calcification in the gluteal bursa.

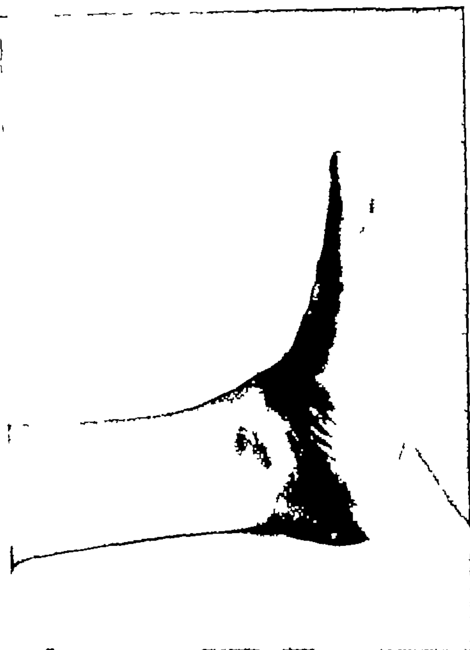


PLATE 35

Metatarsus inversus. Note the medial rotation deformity of the forefoot on the hindfoot.



PLATE 36

Lumbar myelogram A protrusion indents the opaque medium at the fifth level The theca ends at the lower edge of the first sacral vertebra.

the lumbar joints But of course far more pain is elicited when the lumbar movements are tested

The examiner applies his palms to the anterior superior spines of both ilia and leans heavily and evenly here (see Fig 91) the pelvis must not be allowed to rock. His hands hurt locally, of course. It must be made quite clear to the

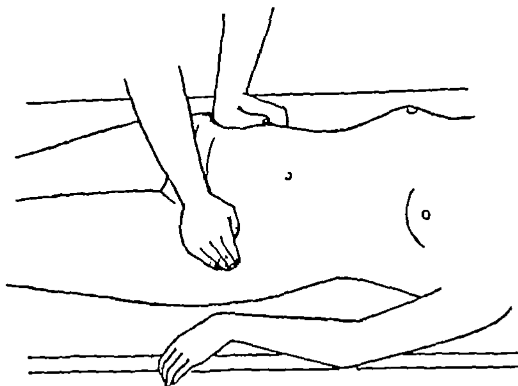


FIG. 91.—Stretching the anterior sacro-iliac ligaments. The patient lies supine and the examiner applies increasing pressure to the anterior superior spines of the ilia in a downward and outward direction. The pressure must be exerted evenly so that the lumbar region does not move.

patient that the point is does this pressure aggravate or reproduce the gluteal pain ?

This is an excellent test, positive in every case though the examiner s whole body weight may be required to elicit pain in very slight lesions.

The anterior sacro-iliac ligaments may also be indirectly strained by forcing lateral rotation at the hip-joint.

Resisted adduction of the thighs against the examiner s closed fist placed between the knees, exerts a strong distracting

force at the sacro-iliac joints. Hence this movement often elicits pain of sacro-iliac ligamentous origin.

2. *Stretching the Posterior Sacro-iliac Ligaments.* The patient lies on his side and the uppermost part of the iliac crest is pressed towards the floor. If the pressure is applied well forwards along the bone, the posterior ligaments bear

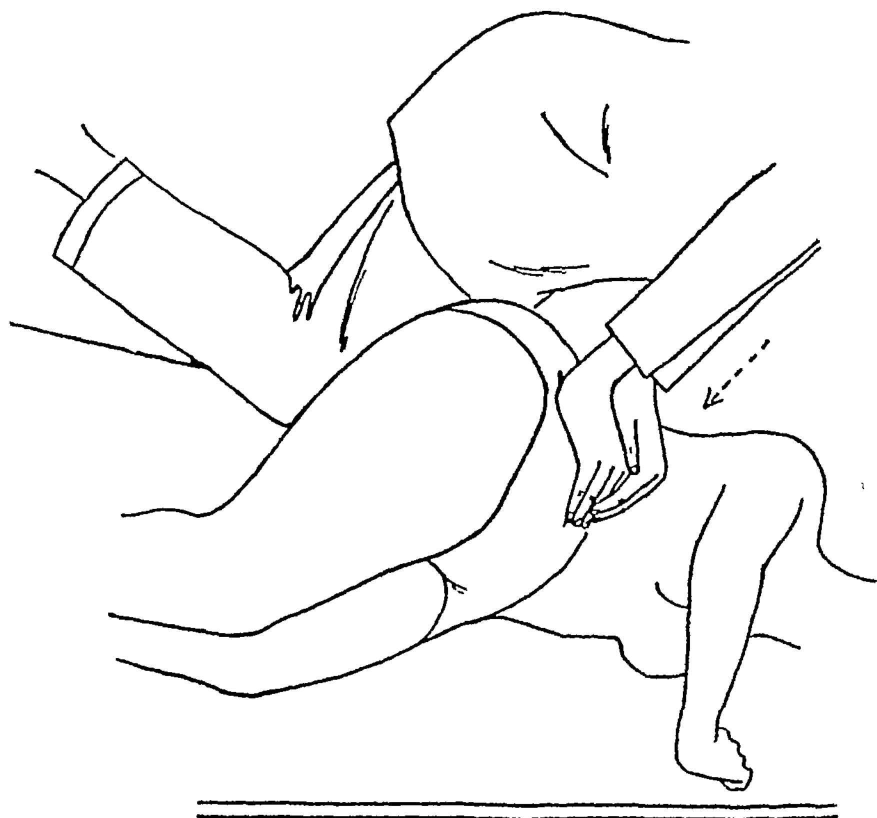


FIG 92—Stretching the posterior sacro-iliac ligaments The patient lies on the painless side while the examiner exerts pressure towards the floor on the antero-lateral part of the iliac crest.

the greater stress (see Fig. 92). This test is much less delicate and gives rise to pain only in severe cases; in half of all patients no discomfort is caused thus Its advantage lies in the fact that the sacrum is not in contact with the couch, thereby obviating confusion between pain due to pressure of the couch on the skin and due to stretching the ligaments.

Forcing full medial rotation at the hip also stretches indirectly the posterior sacro-iliac ligaments.

3. *Forward Pressure on the Sacrum.* This is a repetition

in reverse of the first test for the sacro-iliac ligaments (see Fig 98) The patient lies prone It has the advantage that the examiner can compare the amount of pain—felt in the buttock, not where his hand rests—produced when passive extension of the lumbar spine and forward luxation of the sacrum are attempted in turn In sacro-iliac lesions, transmitted stress usually results in slight gluteal aching when the

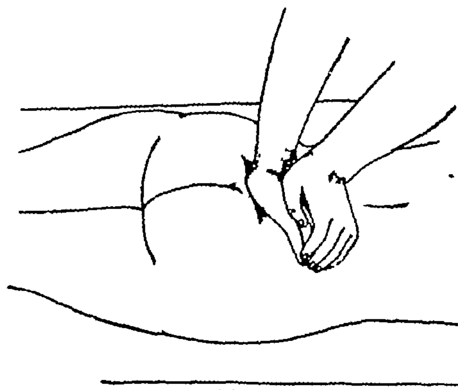


FIG. 93.—Attempted forward luxation of sacrum. The heel of the examiner's hand presses on the centre of the patient's sacrum.

lumbar spine is pushed towards the couch, but much more severe pain is set up when the sacrum is pressed upon

During any of these movements a slight local click may be felt in adolescent boys and in women of childbearing age The click very seldom hurts if it does, reduction should be undertaken at once (see Vol. II)

Confirmation

1 *Negative Component* Examination of the lower limbs reveals no disorder contradicting the ascription of the

symptoms to the sacro-iliac joint. Straight-leg raising is not limited; there are no neurological signs and so on. Each rotation of the hip may prove painful *at full range*; this is a consistent finding, since forcing this movement stretches the sacro-iliac ligaments. In psychoneurosis strong pressure on bony points is often strongly resented, hence the examination must include the lower limb in order to reveal the inconsistencies that indicate the presence of psychogenic pain.

2. *Tenderness "Over the Joint."* A glance at Plate 31, which shows the relations of the sacro-iliac joint, should finally dispose of the idea that tenderness of any structure within reach of the examiner's finger could possibly denote tenderness of the sacro-iliac ligaments. The accessible part of the sacrospinalis muscle lies well medial to the joint. The posterior edge of the ilium overhangs, protecting the joint from palpation. Hence, even if the joint is at fault, tenderness will not be found. By contrast, since referred tenderness is a common finding in lumbar disc-lesions, the discovery of tenderness somewhere in the region of the sacro-iliac joint is positively misleading.

3. *Local Anæsthesia.* This cannot be induced at the anterior sacro-iliac ligaments; hence positive confirmation by local anæsthesia is impossible. It is my practice to carry out a negative confirmation by inducing epidural local anæsthesia, in case, after all, a lumbar disc-lesion should be responsible The sacro-iliac joints are tested, say, a quarter of an hour later and are found still to hurt. This finding excludes a lumbar disc-lesion with false positive sacro-iliac signs.

4. *Radiography.* This may help. In sacro-iliac strain nothing is revealed. This is in keeping with the results of radiography of a skeleton pelvis (J. Young, 1940). Photographs taken with the symphysis pubis closed and forced wide open showed no detectable change at the sacro-iliac joints.

In the sacro-iliac arthritis of early spondylitis deformans, the x-ray photograph often reveals nothing at first. Indeed I have had to keep patients under observation for as long as two years before the tell-tale sclerosis at the iliac side of the lower part of the joint has begun to show. This has been misnamed "osteitis condensans ilii" which is a clear Latin description of the radiological appearances but disguises the

fact that early spondylitis deformans is present In others, the sclerosis may already be apparent, sometimes at the joint not clinically affected, the disorder having progressed silently on that side. J H. Young (1951) points out that in adults, before the sclerosis of the lower juxta articular part of the ilium begins, the fine white lines of sub-chondral bone along the edges of the sacro-iliac joints disappear As a result the joint margins become indistinct In septic arthritis at the sacro-iliac joint, new bone formation may not show up for several months.

It is the widespread belief that a diagnosis of spondylitis deformans is made by inspection of the radiograph, and that a normal appearance of the sacro-iliac joints excludes this disease. This is not so Clinical signs at the sacro-iliac joints often precede by many months the appearance of early sclerosis. In the late case, when one glance at the lumbar spine makes the diagnosis obvious, the radiographic signs are nearly always only too clear Spondylitis deformans spreading up the vertebral column without sclerosis ever appearing on the radiograph of the sacro-iliac joints is a rarity which I have so far met with in three instances only

5 *Sedimentation Rate* This too may help but much can not be expected in the difficult cases. When the disease is obvious, the erythrocyte sedimentation rate is greatly raised, perhaps to 50 mm. or even 100 mm. in the first hour However, in a doubtful case the sedimentation rate is apt to be in the region of 5 to 10 mm and thus prove of no assistance.

Dural Signs in Spondylitis Deformans

Rarely, examination of a patient with spondylitic involvement of the lower lumbar spine shows straight leg raising to be bilaterally limited though an adequate range of hip-flexion with the knee bent is present. Another uncommon phenomenon is pain elicited in the lower lumbar region on neck flexion This pain is temporarily abolished by epidural local anaesthesia but the patient suffers a severe exacerbation lasting several days after the injection

On one occasion I had the good fortune to inspect the lower lumbar extent of the dura mater at laminectomy in a patient later found to suffer from spondylitis deformans It was seen

to be thick, fibrous and a lustreless dark grey. Hence it would seem that this membrane can become involved in the disease. When this happens, the same phenomena of dural provenance are set up as occur so much more often with disc-lesions.

PROGRESS OF SPONDYLITIS DEFORMANS

Sclerosing sacro-iliac arthritis usually takes place silently, for less than 10 per cent of patients with advanced disease can ever recollect having had sciatica.

The first complaint is often vague discomfort and stiffness in the lower back. This comes and goes irrespective of exertion in bouts lasting weeks or months, often with symptom-free intervals of similar length. Then the pain spreads to the thorax, tending to leave the lower lumbar levels. The patient notices that breathing has become restricted, owing to involvement of the costo-vertebral joints; in the end, his respiration becomes purely diaphragmatic. Finally the neck is involved in the painful process, becoming increasingly stiff. The two upper joints are affected very late; hence hyperextension here contrasts with the flattening out of the lumbar lordosis and the marked thoraco-cervical rounded kyphosis. The patient's face becomes pinched and haggard, the eyes hollow and the body loses its fatty covering. Microcytic anæmia is a common, and iritis an uncommon, complication. When bony ankylosis is complete, pain ceases; the pain in the trunk therefore travels upwards and comes to an end after many years

Then the hips become affected. Until t [illegible] the patient, curved and fixed though [illegible] to look up by extending at the [illegible] to be possible and some [illegible] state of crippledom. The [illegible] seldom affected; inc[illegible] to *present* as infective [illegible] lead to involvement of [illegible]

Happily, this se[illegible] speed and extent [illegible] age. I hav[illegible] thirty-fi[illegible]

radiographic evidence of sacro-iliac sclerosis has appeared during this time but the disorder has not yet spread to the lumbar spine. The younger the patient is at the onset, the worse the prognosis, and men do worse than women When spondylitis deformans appears before the age of twenty, crippledom is a virtual certainty Evolution of the spinal component will probably take two to seven years the hips will be affected within five years, treatment or no treatment. By contrast, sacro-iliac arthritis coming on after the age of twenty five may, even in men, go on flaring and subsiding for, say, five or ten years before the lower lumbar joints become involved. Spread upwards may be very slow, and the thoracic spine only become affected by the time the patient reaches forty or fifty The cervical spine may never fix at all, the hips usually retain full mobility indefinitely Sclerosing sacro-iliac arthritis coming on after the age of thirty is quite unimportant, except in so far as the patient may be led mistakenly to believe that he will soon be a cripple. I have once met with a case of sacro-iliac arthritis coming on after the age of forty By this, I do not mean that a patient, perhaps now aged fifty, who first attends enquiring about the reason for the stiffness in his hitherto painless neck, does not have sclerosis or fusion at his sacro-iliac joints. He, however, is not suffering from pain in the buttock or clinical signs incriminating the sacro-iliac joint. He had his sacro-iliac arthritis painlessly years ago

Occasionally the lumbar spine fixes not in flexion but with its ordinary lordosis. Inspection of the patient's back then yields no information, but, directly he is asked to perform trunk movements, the fixation becomes evident and is particularly obvious on attempted trunk flexion Rarely the constitutional signs are absent, the patient is cheerful, looks well, and is amply covered Nothing then in the patient's appearance suggests the diagnosis, but, once more, side-flexion of the lumbar, and probably thoracic, spine is found much restricted

An interesting phenomenon is occasionally encountered The patient, usually aged thirty to thirty five, complains that he may feel a sudden jar in his back on bending to lift a heavy weight, after which his back is painful for some weeks He recovers, but further exertion brings on the

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Then the hips become affected. Until then, the patient, curved and fixed though his back is, has been able to look up by extending at the hip-joints. Now this ceases to be possible and some patients are reduced to a pitiable state of crippledom The knees, shoulders and other joints are seldom affected; indeed spondylitis deformans is more likely to *present* as infective arthritis at the knee or tarsus than to lead to involvement of these joints as a late manifestation.

Happily, this sequence of events is not a certainty. The speed and extent of spread depends on the patient's sex and age. I have, for example, a number of patients now aged thirty-five to forty who have been followed up for ten years;

radiographic evidence of sacro-iliac sclerosis has appeared during this time but the disorder has not yet spread to the lumbar spine. The younger the patient is at the onset, the worse the prognosis and men do worse than women When spondylitis deformans appears before the age of twenty, crippledom is a virtual certainty Evolution of the spinal component will probably take two to seven years, the hips will be affected within five years, treatment or no treatment. By contrast, sacro-iliac arthritis coming on after the age of twenty five may, even in men, go on flaring and subsiding for, say, five or ten years before the lower lumbar joints become involved. Spread upwards may be very slow, and the thoracic spine only become affected by the time the patient reaches forty or fifty The cervical spine may never fix at all, the hips usually retain full mobility indefinitely Sclerosing sacro-iliac arthritis coming on after the age of thirty is quite unimportant, except in so far as the patient may be led mistakenly to believe that he will soon be a cripple. I have once met with a case of sacro-iliac arthritis coming on after the age of forty By this, I do not mean that a patient, perhaps now aged fifty, who first attends enquiring about the reason for the stiffness in his hitherto painless neck, does not have sclerosis or fusion at his sacro-iliac joints. He, however, is not suffering from pain in the buttock or clinical signs incriminating the sacro-iliac joint. He had his sacro-iliac arthritis painlessly years ago

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An interesting phenomenon is occasionally encountered The patient, usually aged thirty to thirty five, complains that he may feel a sudden jar in his back on bending to lift a heavy weight, after which his back is painful for some weeks. He recovers, but further exertion brings on the

same pain again. Naturally, a diagnosis of lumbago is made and the presence of a disc-lesion appears confirmed when the x-ray appearances of his lumbar spine reveal no other cause for his symptoms. In fact he is straining his stiffening lumbar joints, the site of the spondylitic process. Since disc-lesions are very rare at the upper lumbar joints, this sequence of events should be suspected in any complaint of attacks of central upper lumbar pain brought on by exertion. Limitation of movement at the lumbar spine is found and the radiographic appearance of the sacro-iliac joints is confirmative.

SACRO-ILIAC FUSION

This radiological finding designates the final stage of spondylitis deformans. Clinical arthritis precedes radiological sclerosis, later fibrous ankylosis supervenes and testing the joint sets up no pain but marked limitation of movement at the lumbar spine is clinically diagnostic and the radiograph shows bilateral sclerosis. Finally, the intra-articular cartilage disappears and after many years the sacrum and ilia fuse. Bony ankylosis thus results (see Plate 33), coinciding with the full evolution of the disease.

SACRO-ILIAC "OSTEO-ARTHRITIS"

Osteophyte formation at a joint that does not move cannot cause symptoms. Indeed, the osteophytes are evidence of ossification in the sacro-iliac ligaments, in other words of complete and final stabilization of the joints. Hence, the discovery radiologically that osteo-arthritis is present at the sacro-iliac joint positively excludes the joint as the source of whatever symptoms the patient may have. Taken as a disease, osteo-arthritis of the sacro-iliac joints is an imaginary disorder

SACRO-ILIAC STRAIN AND PREGNANCY

In my experience there is often no particular connexion. Women develop sacro-iliac strain indifferently whether pregnant or not. Though it is true that, as can be shown by radiography, slight relaxation of the sacro-iliac ligaments

occurs in some pregnant women, this is physiological. In consequence, testing the sacro-iliac joint does not set up any pain. The existence of a hormone named ' relaxin " (Hisaw *et al*, 1944) is responsible for the ligamentous change Luckily, no appreciable instability of the joints results and even pre-natal exercises intended to increase the mobility at the sacro-iliac joints prove harmless, however, they are best avoided for the sake of the lumbar spine, as nearly all of them involve trunk flexion

Examination of women whose backache dates from pregnancy shows that the cause is not sacro-iliac strain but an early disc-lesion—the result of ten days in bed in ' the nursing mother's position " (see p 358) The facile assumption that merely because a woman s backache started during pregnancy or the puerperium it must be due to sacro-iliac strain is not borne out by clinical examination. This preconception should be dropped, and the patient examined on standard lines

SPECIFIC SACRO-ILIAC ARTHRITIS

This may be tuberculous or septic. In tuberculosis the first symptom is the swelling in the buttock the patient does not experience pain. Fluctuation shows that a cold abscess is present and aspiration followed by inoculation of a guinea pig shows it to be tuberculous Testing the joint does not elicit pain, on account of the fibrous ankylosis produced by the infection.

Septic arthritis is dealt with on p 516

TREATMENT OF SACRO-ILIAC STRAIN

The sacro-iliac is like the acromio-clavicular joint in that no muscle controls movement at the joint, which relies for its stability solely on its capsule and ligaments Hence movement plays no part in the treatment of sacro-iliac strain. Mobilization of the joint, as might be expected leads to further over stretching and increased pain indeed, the stresses put upon the joint by its mere clinical examination temporarily aggravate the symptoms.

The joint requires protection In fact the wearing of a

suitable belt for a month or two abolishes the symptoms, apparently permanently. The most suitable is the "corrugator" (see Fig. 94).

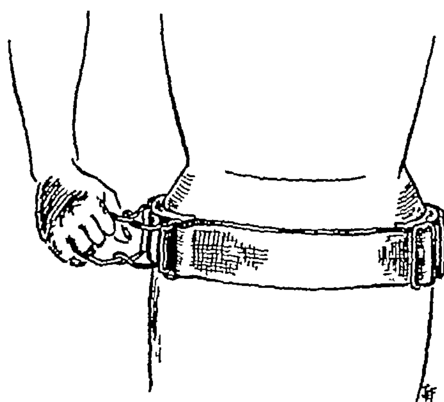


Fig 94—Corrugator belt for sacro-iliac strain (Austlid, Stockholm)

If displacement is present—a great rarity—reduction should be effected at once by Marshall's method (see Vol. II). The belt is applied at once.

TREATMENT OF SPONDYLITIS DEFORMANS

EXPLANATION

When a patient aged over twenty-five is seen at the stage of sacro-iliac arthritis or early lumbar involvement, little need be said to him about future disablement. Unless his job involves very heavy work, he may never become appreciably incapacitated. On the other hand, when a young man, aged say twenty, is training for some career, it is vital that he should be steered in the right direction by a talk with his doctor, his parents and himself. It is best to state that the spine is sure ultimately to stiffen in a way that does not interfere with sedentary work; that the pain is controllable by x-ray therapy and that the disorder does not spread, *e.g.*, to the hands and thus impede manual tasks.

When the spinal column is already stiffening it is wise to explain that the stiffness is permanent but unimportant to a sedentary worker, whereas the pain responds to treatment, eventually disappearing altogether. The patient must be brought round to view his disability in as cheerful a light

as he can, to resign himself to avoid some pursuits, and to adopt work suited to his capacity The question, often put, of spread to other joints can only be answered evasively in young patients, but quite a strong negative is justified to a patient in his or her thirties in whom only the sacro-iliac or lower lumbar joints are as yet affected

The capacity for sedentary work is often not appreciably impaired for years It is not deformity so much as pain keeping the patient awake and rendering his daily life miserable that upsets him

A rigid lumbo-thoracic spine is remarkably little inconvenience to a sedentary worker When the disease spreads to the hip-joints, however, the position is very different. Fixed flexion deformity of the thigh combined with a rigid kyphosis of the lumbar spine is a great disability which must be staved off for as long as possible Thus, as long as the spine is affected alone, the patient often manages very well, whereas any but slight arthritis of the hip is a serious matter for him

The analogy between spondylitis deformans and infective arthritis has suggested the use of injections of gold in treatment. My experience is that they are without effect. Even cortisone appears to bring no lasting benefit. Since no known treatment affects the progress of the disease, the principles underlying treatment are two the prevention of further deformity and the treatment of pain

1 THE PREVENTION OF FURTHER DEFORMITY

This can largely be attained by the adoption of the following routine. The patient should sleep on one mattress on fracture boards, with only one pillow, and should avoid lying curled up on his side. He should lie face downwards on an unyielding couch for an hour—even for less is of some value —in the middle of his working day If he has to sit bent over a desk for any length of time, he should make a conscious effort to pull himself up straight as often as he can remember, not less than once an hour For the prevention of deformity this regimen is more valuable than any physiotherapy However this is indicated from time to time, if pain returns or deformity appears to be increasing The physiotherapist

should force extension at the lumbo-thoracic spine and stretch out both hip-joints towards extension.

Osteotomy at a lower thoracic level can straighten out a gross flexion deformity of the spine.

Recumbency

When, as may occur in some youngish patients, the progress towards complete rigidity is rapid, lying in a plaster bed is the only method of ensuring ankylosis of the spine in good position. During a flare, the degree of pain and the high blood sedimentation rate indicate the need for recumbency. In such cases the physiotherapist can do no more than maintain the strength of the muscles of the lower limbs She should also keep the neck moving since the upper two cervical joints often escape for a long time.

2. THE TREATMENT OF PAIN

Pain arises both in the muscles and the joints in spondylitis deformans Butazolidine (0 2 or 0 4 g. daily) is most effective in alleviating the feeling of stiffness.

Muscular Pain

Examination of the posterior trunk for areas of muscular tenderness should not be neglected merely because the patient is known to suffer from spondylitis deformans. Muscular lesions are particularly easy to relieve by adequate massage, even after some years. Massage has, of course, no effect upon the capsulo-ligamentous pain, or on the evolution of the disease.

Capsulo-Ligamentous Pain

At the Sacro-iliac Joint. X-ray therapy is indicated and subsidence of the pain after the third or fourth exposure takes place in four cases out of five. An exposure of 200 r. given three times a week for a fortnight (*i.e.* 1,200 r. in all) provides for average dosage. Return of pain is to be ex-

pected in six to twelve months if the patient is young, not for some years if the patient is over thirty

In a woman, the sacro-iliac joints cannot be irradiated without danger to the ovaries. A woman over, say, thirty may well elect, if she already has several children, to chance sterilization in the relief of her pain The husband should be a party to this decision.

The Medical Defence Union holds the opinion that the risks inherent in the treatment should be explained to the patient in the presence of a witness and that she should sign a statement that she consents to the treatment knowing and accepting the risks; the witness should also sign the document. This procedure, in the Union's view, adequately safeguards the medical men concerned. As a matter of fact, after a year or two menstruation usually returns. In a younger woman however, the risk must not be run. Ultra sonic waves should be substituted Although not very effective they ease the pain for a short time and provide the best alternative.

Irradiation must be avoided during pregnancy for fear of harming the fœtus. In fact, pregnancy usually abolishes the pain for the time being but the effect does not last. Rarely however sacro-iliac arthritis begins during pregnancy, and continues thereafter

The painfulness of spondylitis deformans is abated by deep x ray therapy, but this has no effect on its eventual evolution The speed of evolution at different ages, however is so different that claims have been made that x irradiation can arrest the disease. I have never found this so, though the patient may have to be followed up for some years before recrudescence takes place. Claims have been made that x ray treatment, particularly that described as "wide-field," arrests the disease This is not my experience. I subscribe to the widely held view that in such cases the diagnosis has probably been made on insufficient evidence (*e.g* on minor deviations from the normal radiographic appearance of the sacro-iliac joints) and that there has in fact been no spondylitis deformans present for the treatment to arrest.

Arthrodesis is, of course, curative locally, but is indicated only in chronic cases of apparently non progressive sacro-iliac arthritis in women aged about thirty

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At the Spinal Column. This may respond to slow stretching of the spine towards extension. Both relief of pain and slight alleviation of the deformity can be gained by this means. The patient, if he is able to, lies prone and the physiotherapist should gently apply increasing pressure downwards, releasing it equally gradually when the patient states that it is becoming unbearable. If he cannot lie prone, the method described in Vol. II should be adopted. The patient should maintain his range of movement by exercises, and should be taught how to move his neck quickly. Exercises towards trunk- and neck-flexion must not be included. Mobilization under anæsthesia is contra-indicated, and, if much is attempted, leads to severe pain lasting several months, but appears to do no permanent harm.

In addition, local deep x-ray treatment should be repeated each time a flare occurs. It does not, of course, prevent eventual ankylosis, but pain of capsulo-ligamentous origin is nearly always fully relieved for a long time. It is not successful in the treatment of muscular pain, for which deep massage should be given. Ultra-sonic waves are an alternative; they often have a short-lived good effect the first time they are employed, but seldom when repeated.

Finally, the patient may be told that the pain disappears when the ankylosing process is completed.

At the Hip, Knee and Shoulder Joints When the hip-joint becomes affected, treatment in the first place consists of gradual stretching of the capsule towards extension, followed by exercises that maintain the increased range, and instruction in gait. The physiotherapist may be told that she need not fear forcing the hip-joint slowly but quite vigorously towards extension, even if the discomfort is considerable. Such stretching out, even when it results in an audible tearing of some articular adhesion, may be followed by immediate relief lasting many months Sooner or later the joint flares again. Muscular spasm then becomes pronounced, pain in the absence of movement appears, and the blood sedimentation rate rises. Recumbency becomes essential, the patient lying flat with only one pillow for his head and avoiding as much as possible a flexed position of the hip. Continuous traction may be required. Spread of the arthritis to the knees also necessitates rest in bed during

the acute phase flexion deformity must be prevented, if necessary, by splintage

Hydrocortisone injected each few days into the joint is strongly indicated during a flare of arthritis at hip, knee, shoulder or elbow This hormone can also be used as a long term measure for relieving inflammation at each affected joint. Four patients can be dealt with at one sitting and the injections repeated as soon as discomfort returns During the chronic phase this may be a month or two

Costo-vertebral Joints These too lose their mobility in the end, but the event should be postponed by mobilization followed by breathing exercises during which the patient uses his own hands to press on his chest and thus help to maintain range (see Fig 52) X ray therapy to the thoracic spine includes these joints in its field.

THE BUTTOCK

Lesions in the buttock are uncommon but often important, requiring treatment urgently They must therefore be recognized clinically at once Before the examiner can approach a patient with an open mind he must discard certain widespread preconceptions.

Gluteal Fibrositis " There are three well known conditions ascribed to the buttock which are in fact imaginary diseases—fibrositis (fasciitis), herniated fibrolipomata and panniculitis. When patients complaining of pain in the buttock are examined by the methods described in Chapter VI, muscle lesions will be found not to occur, apart from direct trauma. Local injury with bruising in the buttock is not uncommon, of course the patient recovers spontaneously in a week or two By contrast, muscle lesions occurring spontaneously (what used to be called fibrositis ") can on every occasion be shown not to be present by the fact that the pattern for any muscle lesion—full range at the joint, one resisted movement hurting—never appears (This fact provides an unexpected contrast with the shoulder joint where tendinous lesions are a commonplace.) Not only that but further examination nearly always demonstrates

that the lumbar movements (rarely testing the hip or sacro-iliac joint) reproduce the gluteal pain. In particular, if trunk extension sets up gluteal pain, the buttock cannot be its source. Trunk extension relaxes every structure in the buttock, apart from the hip-joint itself, thus showing the pain to have, as it nearly always does, a lumbar origin.

Local fibrolipomata exist and to that extent are not imaginary; they are palpable and can be seen on dissection. They can be shown never to interfere with the muscles of the buttock by, as always, testing function. The resisted movements of the hip-joint are examined and, in each instance, found not to hurt.

Symmetrical collections of fat may form in the superficial tissue of the buttocks and on the outer aspect of each thigh in middle-aged women. Again clinical examination shows that they do not interfere with muscle function; but their presence has misled those who rely chiefly on palpation for diagnosis into creating a disease called "panniculitis." It too is a myth.

LESIONS IN THE BUTTOCK

Major lesions in the buttock. These possess in common an arresting pattern of physical signs that draws immediate attention to the buttock. Passive hip-flexion with the knee held extended (*i.e.* straight-leg raising) is found limited and painful. Passive hip-flexion, this time with the knee held flexed, is also found limited and painful Further examination reveals a non-capsular pattern of limitation of movement at the hip-joint. The deductions to be drawn are as follows: Straight-leg raising is limited; the lesion is therefore connected with the tissues lying behind the hip-joint. Hip-flexion with the knee bent is also limited; hence neither the sciatic nerve and its roots, nor the hamstring muscles, are at fault. Were the hip-joint itself affected, straight-leg raising would not be limited (except in gross and obvious arthritis) The only structure left is the buttock. Thus, when the examiner passes on from testing straight-leg raising to testing the passive movements at the hip-joint, he discovers at once that there is "something in the buttock."

There is nothing characteristic about the pain. It is felt

in the buttock and spreads down the back of the thigh to the knee or calf, naturally a disc-lesion is suspected from the history Trunk flexion is limited, since the patient has pain *when tension falls on the tissues of the buttock* the other lumbar movements are of full range. It is only when the patient is examined supine on the couch that the typical combination of signs emerges. This naturally leads to careful examination of the passive and resisted hip-movements A non-capsular pattern emerges on passive testing medial rotation nearly always proving of full range. Moreover, the characteristic feel of a hip-joint at its extreme of range is replaced by the patient's asking the examiner, because of increasing pain, not to force a movement which the latter can clearly feel not yet to have reached its end. The resisted movements often hurt, since they too alter tensions in the buttock.

The patient's temperature is noted, a rectal examination is performed and a radiograph secured without delay

Minor lesions about the hip When a full range of movement is found, there exists a major difficulty in interpreting pain elicited at the extremes of range at the hip-joint and on the resisted movements of the thigh, because the tendons and bursæ about the hip may be painfully stretched or pinched in a manner that does not occur at other joints Hence pain on a resisted movement does not necessarily inculpate the relevant muscle group it may be related to tenderness of an adjacent bursa and for example full passive lateral rotation of the femur not only stretches the capsule of the hip-joint but moves the psoas muscle and bursa and the tendon of the rectus *femoris as well These structures too are pinched* by full flexion in adduction. For this reason the tissues just outside the hip-joint itself are the most difficult to examine of all the moving parts of the body

1 *Gluteal (and Psoas) Bursitis*

Septic bursitis gives rise to the characteristic finding At the time the patient is first seen his pain at rest may not be severe and he may not yet feel ill, but either he hobbles in with a gait suggesting an arthritic hip or he lies in bed

unable to put that leg to the ground or rest that buttock on the mattress. Such disablement contrasts with the degree of pain; much greater pain would have been required to secure such disablement had a disc-lesion been present. The temperature is between 99° and 100° F.; the next day it is a little higher. Rectal examination and the radiograph reveal no abnormality. Palpation may reveal a vague area of tenderness just behind and above the greater trochanter. Rarely a large swelling is encountered lying postero-laterally at the upper end of the femoral shaft, level with the lesser trochanter. Rest in bed and parenteral penicillin lead to full recovery within a week. Recurrence within five years is to be expected.

Very occasionally the same swelling results from acute, often hæmorrhagic, bursitis due to a fall on the outer side of the hip. Pain is slight; the patient walks well. Aspiration suffices.

Chronic bursitis not due to septic inflammation is diagnosable only with difficulty. There is vague discomfort in the buttock and thigh aggravated by walking, rather suggestive of an early osteo-arthritis of the hip. Full flexion at the hip hurts a little; so may full straight-leg raising, but the rest of the examination gives rise to a strong suspicion of psychogenic pain, since the passive and resisted movements hurt in an apparently senseless way. At its extreme a passive movement may stretch or pinch the bursa; a contracting muscle may compress it. Once it is clear that the patient is sincere and that bursitis is present, every effort should be made to identify its position as well as possible by noting which accessory movements elicit pain. If a muscle contraction hurts, the bursa lies in connexion with that muscle. If a painful arc exists on flexion in adduction, the tissue lying near the posterior edge of the greater tuberosity is tender. If full adduction of the femur hurts, the tissues just above the trochanter are stretched. If full abduction of the femur hurts the lesion lies in a pinchable position above the trochanter. If full passive flexion hurts, more with the hip adducted, the lesion is pinched at the front of the hip-joint. By dint of studying the effect of such movements, a fair estimate of the position of the painful bursa is arrived at and occasionally the radiograph shows a calcified deposit. If so, added precision

is achieved (see Plate 34) Whether a deposit is visible or not, the diagnosis is confirmed by the injection of 50 c.c. of procaine solution. This also provides the only necessary treatment. Two or three correct infiltrations suffice to cure, but there is no apparent tendency to spontaneous resolution , for, though the condition is rare such cases as are encountered are often of many years standing

It must be remembered that the femoral artery lies at the front of the hip-joint and indefinite signs of a lesion lying here may be set up by *e g.*, thrombosis of the external iliac artery If so, the ambulant patient's foot on the affected side is cold An obturator hernia also occupies space close to the hip-joint (see p 580) A tuberculous abscess in the buttock caused by infection of the fifth lumbar vertebra or the sacro-iliac joint forms a painless fluctuent swelling that does not interfere with any hip movement.

Alas I, for one, cannot always distinguish between psoas bursitis and gluteal bursitis In one case with symptoms of twenty years' standing signs suggesting bursitis coincided with pain on resisted flexion at the hip A diagnosis of psoas bursitis was made by me, but the radiograph showed calcification in the gluteal bursa. Three inductions of local anaesthesia at this area at weekly intervals afforded full relief which has now lasted two years

2 *Hæmorrhagic Psoas Bursitis*

This is an interesting rarity The patient states that he jarred his thigh, slipping Within a minute, the front of the upper thigh is painful and he finds he cannot flex at the hip-joint. Examination shows 90° limitation of passive flexion at the hip-joint, all the other movements proving of full range There is no pain or weakness on any resisted movement. It is clear that a space-occupying lesion has suddenly appeared at the front of the hip-joint, *i.e* the bursa is tensely filled with blood.

Aspiration proves the diagnosis and cures the patient failing that, spontaneous cure takes three or four months

ascribed to psychological causes only with caution. Most such patients oblige by offering signs to show that the lumbar region, the sacro-iliac and knee joints and the muscles in the

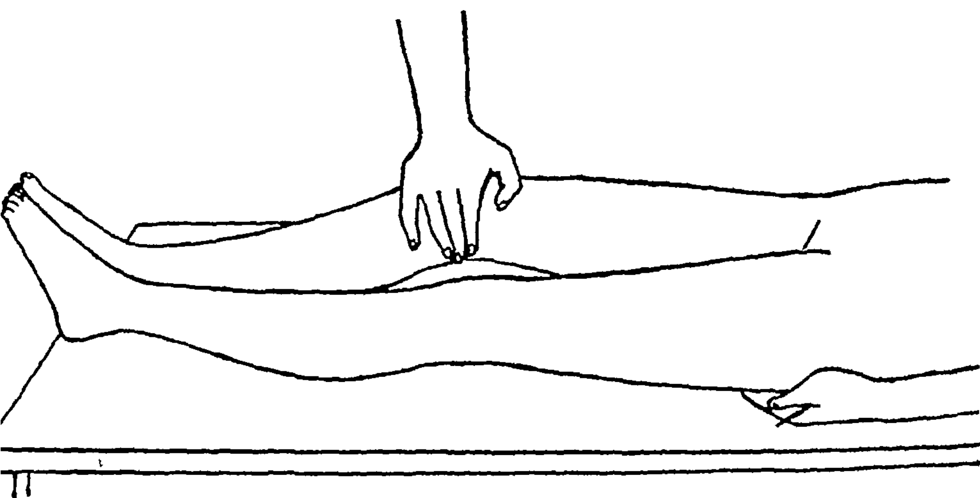


FIG 95 —Resisted flexion at hip The patient presses his knee towards the examiner's hand

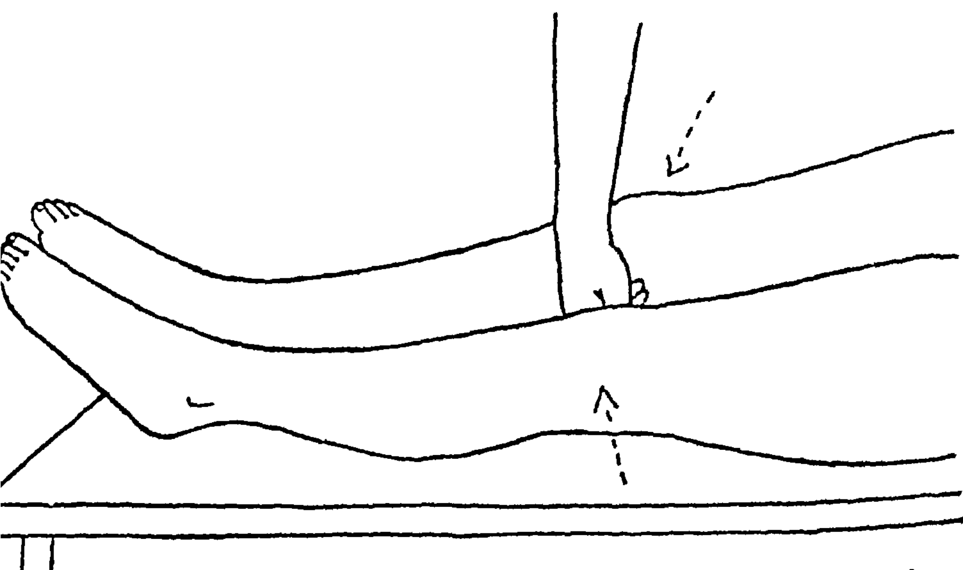


FIG. 96 —Resisted adduction at hips. The patient squeezes the examiner's hand between his knees

thigh are affected as well. It is important to test all muscles and joints in detail, and to perform a number of movements twice—*e.g.* first standing then lying down; or first lying supine then lying prone—to see if the responses tally.

THE HIP JOINT AND MUSCLES

Examination begins by noting the range and painfulness or not of flexion, medial rotation and lateral rotation while

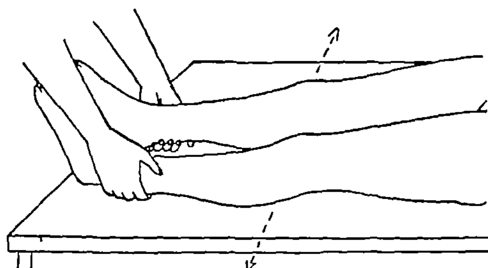


FIG. 97.—Resisted abduction at hips. The examiner faces the patient and resists the abduction movement by holding his ankles together

FIG. 98.—Resisted extension at hip. The examiner resists the downward pressure at the patient's heel.

the patient lies supine, and extension while the patient lies prone. If the range of abduction needs to be tested, the examiner should steady the pelvis by placing his hand on the anterior superior spine of the ilium on the far side. Otherwise he may appear to be abducting at the hip-joint when he is in fact side-flexing the lumbar spine.

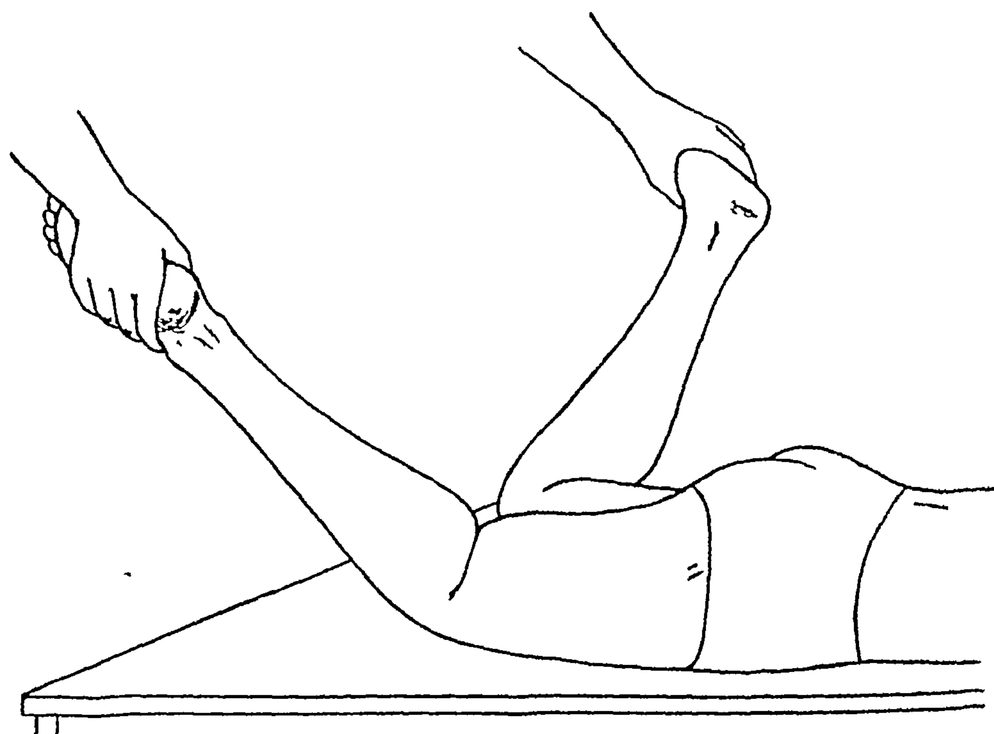


FIG 99—Passive medial rotation at hips. The patient lies face downwards, his knees together The examiner rotates the thighs by pressing the feet apart. The buttocks must be kept level A small amount of limitation of medial rotation becomes detectable. This is often important for this is the movement first to become restricted at the onset of arthritis

The resisted movements (see Figs. 95 to 98) follow: flexion, extension, adduction and abduction at the hip (supine); flexion and extension at the knee (prone).

Muscle lesions at the upper thigh are far outnumbered in adults by lesions of the hip-joint itself; in children this tendency is even more pronounced and nearly all pain felt to spread down from the front of the thigh towards the knee originates from the hip-joint itself. Double lesions, capsular and muscular, are a rarity.

The range of movement at most individuals' hip-joint is:

flexion until the thigh touches the trunk extension 15° to 30° beyond the anatomical position 60° of medial rotation, 90° of lateral rotation, 45° of abduction and 30° of adduction The typical pattern of capsular limitation of movement in gross arthritis is as follows (1) fixed in slight adduction (i.e 50° to 55° limitation of abduction) (2) no range of medial rotation, (3) 90° limitation of flexion, (4) 10° to 30° limitation of extension (5) full lateral rotation. In very early arthritis, medial rotation may be the first movement to become measurably restricted, slight limitation of flexion soon follows.

Referred Pain

The hip-joint is nearly always formed from the third lumbar segment. Hence pain is referred from the groin, down the front of the thigh to the knee, and thence down the front of the leg to just above the ankle (see Fig 17) At times the crural component is absent, the patient complaining solely of an anterior pain at the knee. Rarely, the hip-joint is developed largely within the fourth lumbar segment and the pain spreads along the fourth dermatome to the outer side of the mid thigh and of the leg In such cases, the fourth lumbar pain of sciatica is reproduced.

Pain felt only at the front of the thigh occupies the area of the second and third dermatomes hence its source should be sought at these levels of the lumbar spine, at the hip-joint, and at the anterior and inner muscles of the thigh and at the knee. If the pain spreads down the front of the tibia, only the structures forming part of the third lumbar segment need be examined.

THE HIP-JOINT

Lesions of the Hip-joint in Children

These are nearly all serious and differential diagnosis rests largely on the radiographic appearances. Hence any child found limping or complaining of even a slight ache in the thigh or knee who shows the slightest limitation of movement at the hip-joint should be put to bed there and then and not be allowed out of bed until the result of the x ray examination

is known. This is vital; otherwise, for example, a slipping epiphysis may slip completely and life-long deformity result.

1. *Pseudo-coxalgia (Perthé)* This may be bilateral and is common in boys aged from four to twelve. It is a manifestation of osteochondritis—a disorder of unknown ætiology. The symptoms are trivial, but examination shows marked limitation of movement at the hip-joint. The radiograph shows flattening of the upper surface of the femoral head and a widening of the epiphysial line. As a result, the femoral head no longer fits the acetabulum, and though prolonged recumbency leads to resolution of the arthritis and a good range of movement for the time being, osteoarthritis is very apt to supervene during the patient's late twenties or early thirties.

2. *Tuberculosis of the Hip.* This may be difficult to distinguish from pseudocoxalgia. Clinically the hip is found fixed in flexion, adduction and lateral rotation; muscle wasting is considerable The patient is seldom over ten years of age. Generalized rarefaction and a diminished joint space seen on the radiograph suggest tuberculosis. Immobilization in recumbency with serial radiographs settles the diagnosis.

3. *Slipped Epiphysis.* Since this may be bilateral, but more advanced on one side, the x-ray photograph should include the whole pelvis. For unknown reasons, the epiphysial junction softens, whereupon weight-bearing results in a gradual downward slipping of the head on the neck of the femur. The disorder arises between the ages of nine and seventeen and examination merely reveals the capsular pattern at the hip-joint with pain on passive forcing but not on the resisted movements. The radiograph reveals the state of affairs.

4. *Transitory Arthritis.* Occasionally the radiograph reveals nothing; yet limitation of movement has been found at the hip-joint. The child should be kept in bed for a fortnight. Such rest may result in speedy return of a full range of movement to the joint He is allowed up and examined again a few days later; full range remains The condition is thought merely to result from overuse and has no evil significance for the future.

result of rickets, forming part of the generalized softening of bone. Alternatively coxa vara may result from a previous pseudo-coxalgia Rarely the deformity is congenital. The range of abduction is markedly limited, the other movements may be of full range The radiograph is diagnostic.

6 *Congenital Dislocation* The baby is nearly always female and often nothing is suspected until she is found late in starting to walk. The leg is then found short in unilateral cases Palpation in the groin reveals that the resistance normally afforded there by the head of the femur is absent and the leg lengthens and shortens when the examiner pulls and lets go. The radiograph is distinctive, showing the epiphysis lying above the acetabulum and about half the size of that on the normal side.

Arthritis in Adults

The capsular pattern is present, the resisted movements do not hurt. The following conditions occur

1 *Osteo-arthritis* This is revealed by osteophyte formation and a diminished joint space, especially superiorly, visible on the radiograph. If it comes on before the age of forty it is the result of a severe sprain or previous disease of the hip usually pseudo-coxalgia

It is customary to divide osteo-arthritis of the hip into three clinical stages. During the first stage, there is pain only after the patient has walked some distance, disappearing as soon as he rests. Limitation of movement is not extreme. During the second stage, weight bearing causes an immediate and increasing ache and the patient can no longer lie on that side at night. During the third stage, there is continuous discomfort even at rest, sleep is disturbed and walking very painful. Limitation of movement is very marked Wasting of the muscles of the buttock, and at the front and the back of the thigh, becomes obvious The adduction deformity leads to apparent shortening of the leg Since the patient has to tilt his pelvis upwards on the affected side in order to bring his foot to the ground, this leg appears the shorter to the patient.

Fixation of the hip leads to low backache. No longer being able to extend at the hip the patient moves his whole

persons who experience aching in the upper thigh on exertion associated with *slight* limitation of movement at the hip-joint. It continues unchanged for months. The radiograph reveals nothing. Treatment by stretching out the capsule of the joint is quickly curative and there is no tendency to recurrence within five years. I do not know the nature of this type of arthritis. Pain felt only on full passive rotation occurs in lesions of the psoas muscle, tendinitis of the rectus femoris, gluteal and psoas bursitis, obturator hernia and invasion of the pubic bone by a neoplasm—usually direct extension of a tumour of the bladder.

TREATMENT

1. *Osteo-arthritis*

Osteo-arthritis at the hip-joint is very difficult to alleviate. Full relief from symptoms is seldom attained even temporarily. Cure, even prevention of further aggravation, is impossible.

In the first stage, or early in the second stage, capsular stretching by the physiotherapist under heat analgesia is indicated. The joint is heated by short-wave diathermy and movement gradually forced (see Vol. II). A month's treatment twice a week is often followed by many months of ease. In the end, however, stretching ceases to be effective; but it is well worth while during the first years.

In the late second stage, a raised heel (to compensate for the apparent shortening) and a walking-stick are required.

In the third stage, operation is called for unless the patient is unwilling or too aged, in which case he must use a crutch. Arthrodesis is the operation of choice in unilateral cases; arthrodesis on one side and an arthroplasty on the other when both hips are affected. When unilateral osteo-arthritis comes on in early middle age, the sooner arthrodesis is performed the better, for it is clearly inevitable. In general, however, the time to operate is when pain compels the patient to ask for surgical interference.

A number of other treatments have been tried; they are:

Intra-articular Injections. A solution of one per cent procaine, or procaine and lactic acid, is usually employed.

The simplest approach is the lateral, from just above the trochanter A three-inch needle is required The capsule is very tough and it is easy to feel its resistance when the needle punctures it. Ten c.c. are injected into the joint. Alternatively the capsule of the joint may be infiltrated by a posterior approach A painful reaction lasting a day or so follows, after that the patient is seldom any the better

Deep X ray Therapy This is extremely effective in the very short run. The patient may experience some weeks' or months' marked relief. Then the pain returns to its former intensity

Intrathecal Alcohol Since the capsule of the hip joint is developed from the third lumbar segment, it seemed probable that, if the posterior root of the third lumbar nerve were destroyed by an intrathecal injection of alcohol, the pain of osteo-arthritis of the hip might cease. Cases with clear third lumbar reference were chosen, Dr J D Laycock kindly performed the injection. The patient lay on the unaffected side with a cushion so arranged at the loin that the third lumbar vertebra formed the top of a lumbar convexity Alcohol (0 5 c.c.) was introduced at the third lumbar inter space. Numbness and tingling along the front of the thigh were noted by the patient. However no lasting improvement followed in six cases thus treated Perhaps we should have introduced a larger amount of alcohol, but we feared damage to the spinal cord and stopped at that.

Neurectomy The obturator nerve and the nerve to the quadratus femoris muscle carry most of the sensory fibres to the hip-joint. These can be removed This operation is more favoured on the continent of Europe than in England The result is usually disappointing

Other Operations McMurray's intertrochanteric osteotomy has the advantage of maintaining a small range of movement at the hip-joint and thus preventing the lumbar pain that so often complicates fixation of the hip in considerable flexion Charnley's operation offers an interesting alter native the floor of the acetabulum is bored away and the hip dislocated medialwards. Adduction deformity is automatically corrected Judet's acrylic prosthesis operation is being extensively tried out at present. Nailing the hip by forcing a Smith Petersen pin through the head of the femur

into the floor of the acetabulum fixes the joint but the pin may work loose.

It is clear from this list that the answer to osteo-arthritis of the hip-joint has not yet been found. In my view, the most promising line of approach is the discovery of a substance which when injected into the hip-joint will lead to ankylosis—in other words, a chemically induced arthrodesis.

Capsular ossification accompanies fluorine poisoning; hence intra-articular injection of a fluorine salt in suitable dilution might have a good result. Naturally, animal experiments would have to be carried out first to find out whether a therapeutic dose can be achieved without general toxic manifestations.

2. *Other Disorders*

In *Infective Arthritis* hydrocortisone injected into the joint is effective. Forcing movement is contra-indicated. Since infective arthritis at the knee often responds well to intra-articular injections of gold, this was tried out at the hip, but proved useless. *Spondylitic Arthritis* is best treated by rest in bed with as little flexion at the hip as possible during a flare and gently repeated stretching out of the joint by the physiotherapist between whiles. Fixation is best dealt with by acrylic or cup arthroplasty. The joint nearly always fixes again in the end. Even so, some years usually elapse, during which the patient can walk fairly well, and the operation, in my view, is well worth while. Nothing can be done for *Osteitis Deformans* except to prescribe butazolidine. *Acetabular Protrusion* is treated on lines similar to osteo-arthritis: *i.e.* by stretching the joints out in the early stage and operation, if necessary, later on. The pain originating from the posterior aspect of the capsule of the pseudarthrosis resulting from long-standing *congenital dislocation* can often be permanently relieved by one or two local anæsthetic injections.

Mobilization of the Hip under Anæsthesia. This is not to be undertaken lightly. Though relief lasting some time may be obtained in younger patients with deformity due to a past pseudo-coxalgia or protrusio acetabuli, in elderly patients with osteo-arthritis the neck of the femur may break. At

the best, only evanescent relief follows Infective arthritis is aggravated by forcing movement.

Muscle Lesions

These are all uncommon. In fact, the least uncommon cause of pain felt on several resisted movements at the hip is gluteal bursitis (see p 518)

The Adductor Muscles

If resisted adduction hurts alone, the upper extent of the adductor longus muscle is usually strained usually at the musculo-tendinous junction This is known as rider s sprain , it used to be common but is a rarity nowadays If this point is not found tender, tenderness should be sought at the femoral insertion of the adductor brevis muscle. The treat ment is deep massage (see Vol. II) If the injury is recent, local anæsthesia may help

Pain on resisted adduction occurs in fracture of the os pubis. This may follow a fall, or may be a stress fracture coming on without any injury If therefore no tenderness of the adductor muscles can be found in a case of pain on resisted adduction, an x ray photograph should be taken of the pubic bone. No treatment is required Union is established in six to eight weeks If resisted adduction hurts in the buttock, the examiner must remember that this movement distracts the ilium from the sacrum and is painful in lesions of the sacro-iliac joint.

The Psoas Muscle

A lesion here is a rarity, but a pleasure to meet for it is most amenable to treatment, but continues for years otherwise.

Pain arising from the psoas muscle may not be elicited when resisted flexion is tested as the patient lies on the couch, since the upper part of the quadriceps muscle then shares the strain with the psoas. The hip should be bent to a right angle and the movement tested again Should this movement hurt, the accessory localizing sign is pain on full

passive flexion of the hip, especially if carried out in adduction. Should the lesion be squeezable thus, the part of the psoas lying at the front of the hip-joint is affected. Difficulty arises when a psoas lesion complicates early osteo-arthritis. Hence the resisted movements should always be tested, even if osteo-arthritis has already been found present. The chance is a remote one, but since a strained psoas responds so well to treatment, it must never be missed. The local anæsthesia that is employed to confirm so unlikely a diagnosis often affords considerable, sometimes full, relief. If the pain returns to its original intensity after injection, deep massage is given to the affected fibres. Luckily these lie immediately below the inguinal ligament, just medial to the inner edge of sartorius, where they are accessible to the physiotherapist's finger on deep palpation.

An obturator hernia interferes with the pelvic course of the psoas muscle, pressing on it from behind. If the patient lies in the Trendelenburg position for ten minutes, the pain on resisted flexion eases. This test appears to be pathognomonic.

Slight discomfort on resisted flexion may be felt when a partial rupture is present at the upper extent of the quadriceps muscle or in tendinitis of the rectus femoris. If so, resisted extension of the knee, tested with the patient prone so as to maintain extension at the hip, brings out the pain more clearly. For this reason, the two resisted movements at the knee are always included in the examination of the hip.

Weakness accompanied by increased pain when the psoas muscle contracts is found in two conditions: (1) Traction-fracture of the lesser trochanter occurs in schoolboys. The onset is not sudden. Weakness and pain are elicited when the resisted movement is tested. The patient is put to bed in a half-sitting position for two or three weeks. When walking no longer hurts, he can be allowed up. (2) Abdominal neoplasm infiltrating the psoas muscle.

Weakness unaccompanied by increased pain on testing flexion against resistance is found in two other conditions: (1) Weakness of the psoas muscle forms a minor part of a third lumbar root-palsy (see p. 424). (2) Secondary deposits at the upper two lumbar levels also lead to weakness of the psoas.

Gluteal Muscles

Lesions of these muscles appear not to occur apart from direct bruising In such cases, spontaneous recovery seldom takes longer than ten days, it is somewhat hastened by local anæsthesia or deep massage. Dancers anxious to get well at once should receive treatment.

Weakness of abduction accompanied by pain in a schoolboy suggests a traction fracture of the greater trochanter Painless weakness typifies congenital dislocation of the hip The greater trochanter has risen so high that contraction of the gluteus medius muscle has become ineffective. As the patient walks, the result is a characteristic dipping of the pelvis towards the leg that is off the ground—the Trendelenburg gait

The Ilio-tibial Band

In spite of a widespread impression to the contrary, "contracture" of the ilio-tibial band does not cause symptoms

The test for the band is that devised by Ober It is performed as follows the patient lies on his unaffected side with the limb in contact with the couch flexed at hip and knee.

1 The knee of the upper leg is grasped by the examiner and the thigh completely abducted in flexion.

2 The thigh is then fully extended while held in abduction By this means the greater trochanter is manœuvred under the ilio-tibial band. While kept extended, the thigh is allowed to drop by its own weight. It is held that failure of the knee to fall until it touches the couch indicates tightness of the ilio-tibial band In fact, most normal men show a positive response to Ober's test, which cannot, therefore, be regarded as indicating any lesion

In fact, sprain of the ilio-tibial band is a rare injury occurring only in dancers. The characteristic signs are (1) Pain on trunk side-flexion towards the painless side, increased if the patient stands with his legs crossed before he bends sideways (2) Pain on full passive adduction at the hip (3) No pain on any other passive hip movement. (4) No pain on resisted abduction at the hip, or when the other resisted movements are tested

Local anæsthesia should be induced at the painful spot just behind and above the greater trochanter. A few sessions of massage on this spot are warranted if the patient is in a hurry to dance again.

Quadriceps and Hamstring Muscles

Partial rupture from indirect violence with, often, the formation of a hæmatoma is common in athletes. During some strenuous movement the patient feels something give way; he supplies the diagnosis correctly himself. Though the pain is not severe at the time, that evening and next morning the pain and disablement are considerable. Direct trauma, *e.g.* a kick on the thigh, may be responsible.

Resisted flexion and extension of the knee are examined with the patient lying prone, the hip being thus kept extended. Pain felt in the groin on resisted extension shows some part of the upper quadriceps muscle to be at fault. This used to be termed "cricket leg" and mistakenly ascribed to rupture of the sartorius muscle. If the rupture is at all extensive and a hæmatoma is present, passive knee-flexion will be found limited as long as the patient stays prone. When he is turned to lie supine, a full range of knee-flexion is revealed. This is due to the quadriceps muscle being released above as fast as it is tautened below when the hip-joint and knee-joint are flexed simultaneously. A third lumbar disc-lesion is the only other condition in which the possible range of knee-flexion alters according to whether the hip is kept extended or flexed. Both are instances of extra-articular limitation of movement with a sign dependent on the constant length phenomenon (see p. 108). Tenderness, hardening of the muscle by effused blood and fluctuation demonstrate the site of the lesion.

Tendinitis of the rectus femoris shows itself by pain on resisted extension at the knee coupled with pain on full passive flexion of the hip, especially flexion in adduction. This implies that the lesion lies in a pinchable position.

When resisted flexion at the knee hurts at the back of the thigh, the hamstring muscles are at fault. If the sprain is tendinous and lies at the ischium, straight-leg raising is of full range. If a hæmatoma is present after a rupture in the

belly, straight leg raising is limited, though hip-flexion with the knee bent is of full range—the constant length phenomenon again

Treatment in either case consists in aspiration of the hæmatoma the immediate induction of local anæsthesia (at least 50 c.c.), prolonged deep massage to the whole area of the tear and to the hardish swelling on either side due to infiltration of the belly with blood Voluntary movement without weight bearing is encouraged from the first and faradism is of real value. It should be given with the knee passively kept fully flexed (for the hamstrings) or the knee held passively fully extended and the hip flexed (for the quadriceps) Progress is slow after a fair sized rupture, especially towards the end In sprinters a recurrence is quite common unless too early a return to racing is prevented by continuing treatment for a fortnight after clinical examination shows the patient to have fully recovered

CLAUDICATION IN THE BUTTOCK

This is a rare condition Unless the suggestion contained in the history is noted, the disorder may prove most puzzling for the pain is felt at mid buttock just where symptoms due to a low lumbar disc-lesion are so often experienced

History

The patient states that after walking for fifty or a hundred yards he gets such a pain in his buttock that he has to stop He stands still and the pain goes After a minute or two he walks on and can cover the same distance before the pain comes on again

Examination

This is essentially negative. The movements of the lumbar spine, the hip-joint, and testing the buttock and thigh muscles against resistance—none of them hurts. Pulsation in the arterial tree of the limb is found adequate. If an epidural injection is given, it does not affect the symptom.

When this condition is suspected the patient should be

asked to lie prone. He should then be told fully to extend his hip, and actively to keep his lower limb off the couch for several minutes. The result of this maintained gluteal contraction is the recognized pain in the buttock. When the same manœuvre is carried out on the sound side, no discomfort results. Moreover, passive extension at the hip is painless.

This diagnosis can usually be proved to be correct by radiography. This shows a dense unilateral calcification of the internal iliac artery.

No treatment is effective except the insertion of an arterial graft.

CHAPTER XX

THE KNEE

AT the knee, the number of different conditions that can occur is larger than at any other joint. Yet an exact diagnosis can be made at the knee with greater certainty than at any other joint, partly because of the different symptoms that characterize different lesions, and partly because the greater part of the joint with its ligaments and tendons is accessible to direct palpation.

EXAMINATION OF THE KNEE

At the knee-joint, the examination has to be conducted in the light of the probability revealed by the history, for, taken by itself, the clinical state of the knee is often not diagnostic.

Pain Referred to the Knee

Lesions of the knee-joint give rise to pain felt accurately at the knee, often at some particular part of the knee. An impacted loose body complicating osteo-arthritis is the only disorder of the knee that is apt to set up pain referred up the thigh and down the leg even so it is usually quite clear to the patient that the symptoms start at the knee.

The front of the knee represents the central portion of the third lumbar segment. Hence the origin of pain referred to this area should be sought within this segment. The diagnostic point in the history, when pain felt at the knee is referred is provided by the indefinite area of which the patient complains He may point to the whole suprapatellar area, and may have noted an ache running up the front or inner thigh towards the groin The two principal structures apt to give rise to referred anterior crural pain are the hip-joint and the third lumbar nerve-root less often the quadriceps or psoas muscle is at fault. In a third lumbar disc-lesion the pain usually begins in the buttock, later affecting the front of the thigh, it is not aggravated by exertion or walking but a

cough often hurts. Such a history exculpates the knee. When the hip-joint is at fault, the pain is diffuse, though often worst at the knee; it is aggravated by walking and the patient may describe attacks of the knee suddenly letting him down. Only the extent of the pain then makes the examiner cautious, but the finding of a normal knee on clinical examination naturally focuses attention on the hip. A common error is to have an x-ray photograph taken of an elderly person's knee because of pain felt there; to find it osteoarthritic (a fair certainty) and regard this finding as diagnostic. Any lesion of the upper part of the quadriceps muscle may set up pain felt to radiate diffusely about the front of the thigh; it usually ends abruptly at the lower border of the patella. The origin is identified only when the resisted movements of the knee are tested

The back of the knee is developed from the first and second sacral segments. Disorders of the knee itself very seldom cause posterior pain only. Hence the source of pain felt there is most often pressure on the first sacral nerve-root as the result of a fifth lumbar disc-lesion. Primary posterolateral pulpy protrusions at this level quite occasionally start with pain felt only at the back of the knee, nothing whatever being felt in the buttock at first. However, the patient may notice that sitting or coughing hurts his knee whereas walking does not. A lesion of the upper calf muscles, whether ischæmic or due to a minor rupture, causes pain correctly attributed by the patient to the back of his knee.

HISTORY

A good half of the examination at the knee consists in taking a detailed history, starting at the moment the symtoms began and following the course of events until the present moment. A short list follows of the more important points that must be ascertained.

What is the age and occupation of the patient? What was he doing when the pain was first felt? In what position was his body and his leg, and what forces were acting on his knee at the time? Alternatively, did the pain come on for no apparent reason? Did the knee give way; if so, did the knee lock; if so, did it lock in extension or flexion; if so, how

did it get unlocked? On which side of the knee was the pain or was it right inside, or was it all over? Did the pain change sides? Did it spread, if so, where to? Was the patient able to walk? Did the joint swell if so how quickly? For how long was he disabled? Were there recurrences, if so what brought them on? How did they progress? What is the effect of going up and down stairs, is down more troublesome than up? Are there sudden twinges? Does the knee click? Does it grate? Does it feel as if it might give way, if so, does the patient actually fall? What treatment has he had, and with what effect?

INSPECTION

The slow onset of diffuse swelling and the adoption of a flexed position of the knee suggest advanced arthritis, with fluid in the joint or synovial thickening sometimes both Limitation of extension coming on suddenly suggests displacement of part of a meniscus The speed with which an effusion appears after an injury is significant if it appears in a few minutes, it is hæmorrhagic if in some hours, it is probably serous. Localized swellings are usually caused by bursæ, especially the prepatellar and the semi membranosus The latter can be seen to project only when the knee is held in full extension.

Muscular wasting is noted, but has no great diagnostic value unless it is extreme, when it suggests specific or infective arthritis Reddening of the skin suggests sepsis or gout. Enquiry is made of the existence of arthritis elsewhere.

The alignment of the tibia on the femur is noted A genu valgum deformity in a child may be due to rickets or to a valgus position of the heel from inversion of the fore-foot, but it often comes on apparently causelessly and disappears with growth Some degree of genu varum is normal in babies Its development in an elderly patient suggests osteitis deformans.

PALPATION OF THE STATIONARY JOINT

Site of Tenderness

Since most of the soft structures about the knee are within

finger's reach, the site of tenderness is always sought when history and physical signs combine to show that an accessible structure is affected.

Heat

The discovery of heat means that the lesion, whatever it may be, is in the active stage. The knee must be examined anteriorly and at each side, for localized heat naturally has a strong diagnostic value. The joint should be palpated again at the end of the examination of movements, for it may have been rendered warm merely by the minor stresses entailed. The discovery of heat indicates: (*a*) recent injury or operation, (*b*) blood in the joint, (*c*) bacterial or infective arthritis, (*d*) a loose body impacted within an osteo-arthritic joint, (*e*) gout, (*f*) fracture, (*g*) osteitis deformans.

Fluid

Testing for fluid in the knee-joint can be done in two ways.

Patellar Tap. Unless the joint is very full, the suprapatellar pouch is first emptied by manual pressure with the palm of the hand. Fluid, if present, is thus forced downwards, lifting the patella off the femur. The patella can be felt to hit the femur with a palpable tap as it is pushed smartly backwards by the examiner's other hand. In the normal knee, the cartilaginous surfaces of patella and femur are already in contact and thus cannot be made to click against each other (see Fig. 100).

Eliciting Fluctuation. This is a more delicate test and should therefore always be preferred to the above manœuvre. The examiner places his thumb to one side of the patella, and one of his fingers to the other. With the palm of his other hand over the whole suprapatellar pouch, he presses backwards. If fluid lies in the suprapatellar pouch, it is made to run towards the lower part of the joint and thus will push apart the fingers of the examiner's *other hand* (see Fig. 101). Even the presence of only a little fluid can be detected in this way. By this method—but not by eliciting patellar tap—experience enables the examiner to tell blood from clear fluid. Blood fluctuates *en bloc* like a jelly moving, whereas a clear effusion runs up and down piecemeal.

Fig 100.—Test for fluid in the knee-joint: patellar tap. If the patella is raised from the femur by fluid, it can be felt to tap against the bone when jerked downwards by the examiner's finger Unless the joint contains a good deal of fluid, the suprapatellar pouch must first be emptied by the pressure of the examiner's other hand.

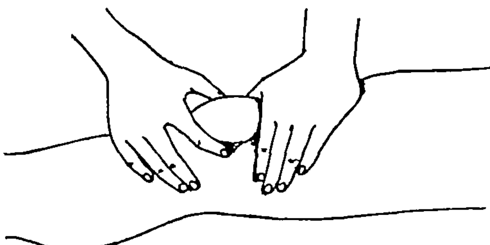


Fig 101.—Test for fluid in the knee-joint: eliciting fluctuation. The ex aminer lays one hand flat on the suprapatellar pouch. Pressure here forces fluid into the lower part of the joint. If fluid is present, the fingers of his other hand, lying to each side of the patella, are forced apart as the pressure is applied.

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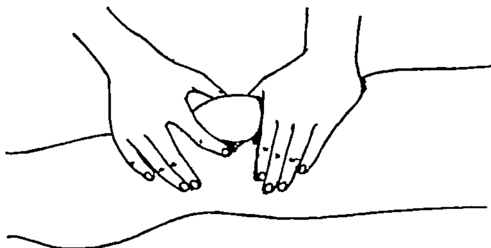
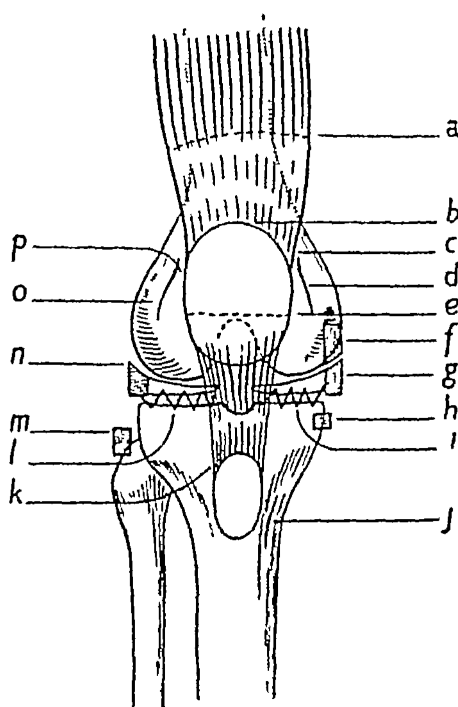


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Whenever the question arises of blood in the knee-joint, diagnostic aspiration is called for at once. If there is any question of hæmophilia, an ampoule of Russell snake venom should be at hand for use to prevent, if necessary, oozing at the site of puncture. Not only is the diagnosis thus established, but aspiration forms the important therapeutic measure.

Synovial Swelling

Whether the synovial membrane is thickened or not is difficult to estimate at times; yet it may be a vital clinical



(a) Musculo-tendinous junction
(b) Insertion of suprapatellar tendon
(c) Quadriceps expansion
(d) Capsular attachment to the femur.
(e) Usual site of transverse patellar fracture
(f) Medial collateral ligament upper end.
(g) Medial collateral ligament. at the joint line.
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(i) Medial coronary ligament
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(l) Lateral coronary ligament
(m) Biceps tendon
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Fig 102—Knee: points of tenderness

finding. The examiner's finger should seek the membrane where it overlies each condyle of the femur, about three-quarters of an inch behind either edge of the patella. He rolls

this edge under his finger, carefully comparing the two knees Synovial swelling indicates a bacterial or infective arthritis (*e.g.* tuberculosis, gonorrhœa, Reiter's disease, ulcerative colitis, spondylitis deformans) Warmth and fluid without synovial swelling suggest traumatic arthritis (including that secondary impaction of a small loose body) recent injury, fracture or operation, or blood in the joint. Localized warmth felt after the examination of the joint, not present at first, characterizes an impacted loose body complicating osteoarthritis.

Other Findings

Palpation clearly reveals osteophytes of any size. Bony deformity may be seen and felt, *e.g.* upper tibial fracture, or the enlargement of the patella that results from an old stellate fracture or osteitis deformans. The bony expansion caused by neoplasm or chronic osteomyelitis can be felt. When osteitis deformans affects the tibia, the sharp anterior edge is eventually lost and the front of the leg may be warm Prominence of the tibial tuberosity left after Schlatter's disease has subsided has no significance in adult life. Syphilitic periostitis is very rare, traumatic periostitis not uncommon. A prepatellar bursa is most easily felt when the tissues at the front of the patella are pinched up Calcified areas in the suprapatellar pouch are palpable.

Intra articular loose bodies should be sought if the patient mentions severe momentary twinges or locking Since the radiograph does not reveal cartilaginous fragments loose in the joint, search by palpation is most important

A cyst of the lateral meniscus can be felt by palpation along the joint line during extension When the knee is flexed, the small projection disappears

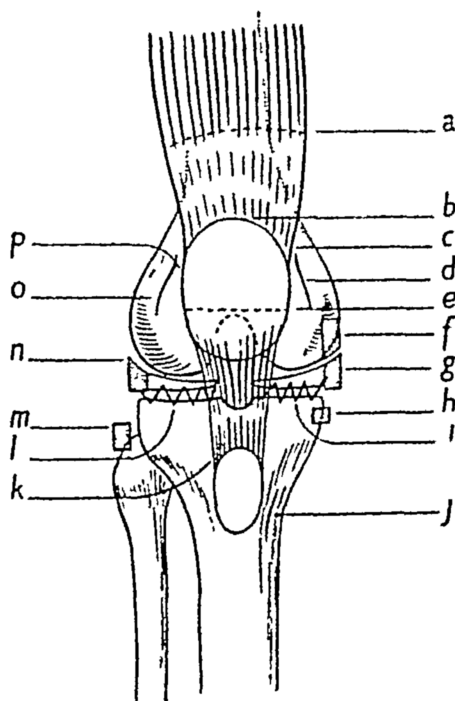
PALPATION OF THE MOVING JOINT

This discloses the state of the opposed surfaces of articular cartilage. It may reveal fine crepitus, some degree of which is a normal finding in all middle-aged individuals. Coarse crepitus indicates marked fragmentation of the surface of articular cartilage. If bone is felt creaking against bone,

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cartilage has become completely eroded. If the knee is palpated while the patient stands, first flexing then extending his knee, femoro-patellar crepitus is elicited in osteo-arthritis of the patella-condylar joint or in chondromalacia patellæ. If the patient is examined lying down the patella is not kept strongly applied to the front of the femur by muscular action and the marked crepitus characteristic of this condition cannot be felt.

A number of other manœuvres are appropriate if evidence of a ruptured meniscus is sought (see p. 552).

PASSIVE MOVEMENTS AT THE KNEE

The primary movements are four · flexion, extension and rotation each way during flexion. If limitation of movement in all directions is found, severe arthritis is present. The capsular pattern is great limitation of flexion and slight limitation of extension. For example, 5° or 10° limitation of extension corresponds with 60° to 90° limitation of flexion. Rotation is also restricted, equally in each direction. A painful arc should be noted; it occurs in impaction of a loose body, patellar-femoral arthritis and, rarely, with a torn meniscus.

The secondary movements, picking out particular ligaments, are also four: varus and valgus strain (for the collateral ligaments); anterior and posterior pressure on the tibia (stretching each cruciate ligament).

Since the findings on testing the passive movements at the knee have to be related to the history and the findings on palpation, their interpretation will be considered seriatim below.

THE RESISTED MOVEMENTS AT THE KNEE

These are best examined as the patient lies prone (see Fig. 103) but may for convenience be tested supine (see Fig. 104). The primary movements are two: flexion and extension. Pain on a resisted muscular contraction is noted, likewise weakness, likewise the two together. If extension is found painful, a lesion of the quadriceps muscle is present; if it is painful and weak, a fractured patella or a major rupture

of the belly is the cause, if it is weak but the muscular contraction does not hurt, a third lumbar root palsy is suggested. If flexion is found painful, medial and lateral rotation are

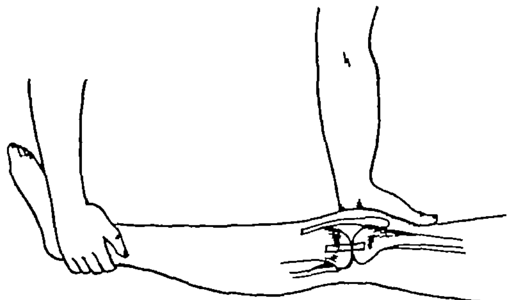


FIG 103.—Application of valgus strain. The knee is forced medially and the ankle laterally; as a result the inner aspect of the knee is stretched.

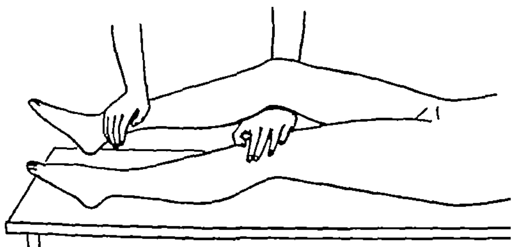


FIG. 104.—Resisted extension of knee. The examiner passes his forearm under the knee and supports his hand on the other knee. The patient's flexed knee rests on his lower forearm. The extension movement is resisted by the examiner's other hand at the ankle.

tested against resistance while the knee is held passively flexed, this test distinguishes between the biceps (lateral rotator) and the other members of the hamstring group (all medial rotators)

cartilage has become completely eroded. If the knee is palpated while the patient stands, first flexing then extending his knee, femoro-patellar crepitus is elicited in osteo-arthritis of the patella-condylar joint or in chondromalacia patellæ. If the patient is examined lying down the patella is not kept strongly applied to the front of the femur by muscular action and the marked crepitus characteristic of this condition cannot be felt.

A number of other manœuvres are appropriate if evidence of a ruptured meniscus is sought (see p. 552).

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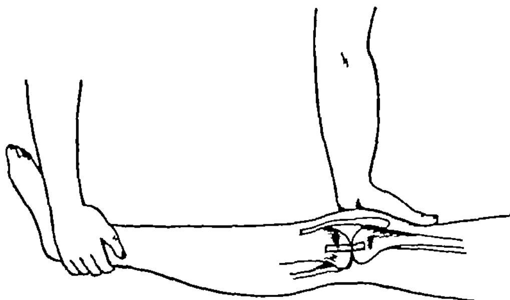


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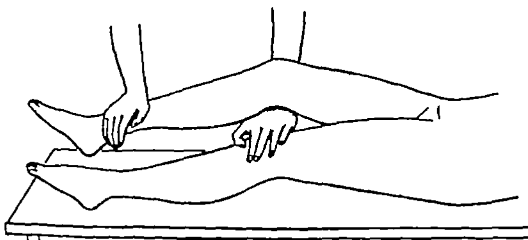


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tested against resistance while the knee is held passively flexed, this test distinguishes between the biceps (lateral rotator) and the other members of the hamstring group (all medial rotators)

DISORDERS OF THE KNEE-JOINT

The following conditions occur at the knee; the history taken together with the physical signs forms a series of characteristic patterns, though neither, taken alone, may be diagnostic.

1. LIGAMENTOUS SPRAIN

(a) Medial Collateral Ligament

History. The patient falls awkwardly while ski-ing or strains the inner side of his knee on the football field. A strong valgus strain is imposed on his knee; he feels a sudden pain at the inner side of the knee, sometimes a crack. He is disabled at once, hobbling with assistance. By some hours later the knee begins to swell and the pain gets worse. He has to spend some days in bed He limps about in great discomfort for several weeks. Then the pain and swelling slowly subside; after two or three months he has largely recovered.

Signs. In the acute stage, which lasts up to a fortnight, the knee is full of fluid, hot to the touch, and extension is 5° limited, flexion 90° limited. An acute traumatic arthritis is present, obscuring all other signs. But the patient knows that he sprained the inner side of the joint and localized tenderness is easily found at some point along the ligament, as it is followed from femur to tibia.

In the subacute stage, which lasts four to six weeks in the untreated case, the limitation of movement at the knee slowly diminishes. The knee remains warm, more so at the inner side. Testing the ligament by applying valgus strain is then painful, whereas varus strain is not. Testing the cruciate ligaments (on p. 546) proves painless. If the ligament was over-stretched and is now permanently lengthened, an excessive range of valgus movement is shown to exist when the two knees are compared. In many cases, adhesions consolidate themselves and the chronic stage is reached (see p. 547)

Localization. The medial collateral ligament is nearly always damaged at the point where it crosses the joint line

and is attached to the medial meniscus Nevertheless its whole extent must be palpated The lower part of the tibial attachment is never affected, the lesion lies, in order of frequency (1) at the joint line (2) at the femoral origin, (3) at the tibial condyle Puzzling signs are found when the lesion lies high up on the femoral condyle, when this motion less part of the ligament suffers contusion, very little, or no, limitation of movement may result, yet the knee is warm contains fluid and valgus strain hurts. Palpation reveals the reason.

(b) *Lateral Collateral Ligament*

This is very seldom sprained. If it is, the articular signs are less severe, owing to the less intimate attachment of this ligament to the joint compared with the medial ligament. Hence the knee is warm, contains fluid, but the range of movement is almost full from the first. The patient knows that he sprained the outer side of his knee and varus strain hurts Palpation of the ligament discloses the site of the lesion.

(c) *Coronary Ligament*

History The patient describes a rotation strain, usually at football. He stands on one foot and, wishing to kick to one side, twists his body on this leg He feels an immediate pain in his knee, localized to the inner or the outer side. He may fall to the ground but gets up again almost at once and may even be able to go on playing That evening the knee is painful and swollen the next day he hobbles with difficulty The sprain resolves very slowly, usually (unless properly treated) taking at least three months to recover

Signs The coronary ligament attaches the meniscus to the edge of the tibial condyle. In extension at the knee, the menisci are forced forwards, thus stretching the ligament. What ever the degree of flexion the semilunar cartilages lie in a neutral position, undisturbed Hence extension is characteristically the painful movement in coronary sprain flexion is free. Medial rotation tends to stretch the lateral coronary ligament lateral rotation the medial coronary ligament

hence one or other of these passive movements is painful but not limited.

Examination soon after the accident shows the knee to be warm and filling with fluid, extension being 5° limited whereas flexion is merely full and painful. One rotation movement is full and painful, the other full and painless. The pain is at one side of the knee; the history of a sprain is clear; yet varus and valgus strains do not hurt. This rules out the collateral ligaments; it follows that one or other of the coronary ligaments has been strained. Tenderness is sought with the knee well bent and the coronary ligament found tender, the collateral ligament not.

After a time, full extension returns, but the warmth and fluid persist for several months in the absence of adequate treatment.

(d) *Cruciate Ligaments*

Recent Injury. The history is of a sprain, but not in any characteristic direction. Hyperextension may be responsible. Examination shows a warm and swollen knee, with a full range of movement in each direction, all extremes hurting; for the cruciate ligaments limit rotation as well as extension (the anterior is then taut) and flexion (the posterior is taut). Valgus and varus strain cause no pain but when the tibia is rocked backwards (stretching the posterior cruciate ligament) and forwards (stretching the anterior ligament) one or other of these movements is painful (see Fig 105). After a severe injury permanent lengthening is common; if so, an excessive range of antero-posterior movement of the tibia on the femur is detected when the two sides are compared. No tenderness is elicitable; for no part of either ligament is accessible. Adhesions cannot form about the cruciate ligaments; the trouble is that the range of movement becomes too great, not too small.

Recovery is very slow; it often takes six months.

Permanent Lengthening. The history is now most misleading; for it simulates closely that of a ruptured meniscus. The patient states that he suffered a severe injury to his knee a year or more ago; ever since, he has had to be careful of his knee. If he twists on it, the knee appears to him to "g

out" with a click and he has to stand on the other leg and give his leg a shake, there is another click and all is well. Actual subluxation of the tibia on the femur by rotation during

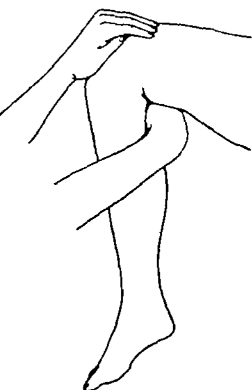


Fig. 105—Stretching anterior cruciate ligament. The patient relaxes his muscles and the tibia is pulled forwards on the femur while the knee is held at a right-angle.

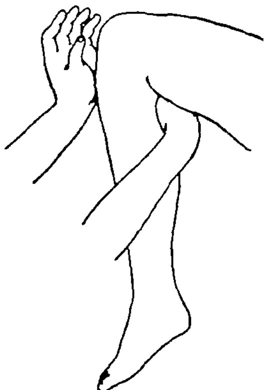


Fig. 106—Stretching posterior cruciate ligament. The knee is held passively at a right-angle and the tibia pushed backwards on the femur

weight bearing is being described. It is only when the cruciate ligaments are tested during the routine examination of the knee that the nature of the disorder becomes obvious

2 POST TRAUMATIC ADHESIONS

History

A common history is that of a sprain of some part of the knee, followed by swelling which has been treated by a few days', possibly weeks, rest in bed and then by gradually increasing use. After a time the knee has become quite adequate for ordinary walking but hurts at one small spot when

the patient takes vigorous exercise, and is apt to become stiff after he has kept it still for any length of time, e.g. sitting. It is clear that abnormally adherent scars have been allowed to form about the torn structure during the period of healing. Quiet use of the knee does not pull at these adhesions; exertion does. Thus vigorous exercise of the knee each time sprains anew the ligaments whose mobility is impaired. Each time, after a few days, the pain and swelling subside and the knee gives no more trouble until exerted again.

Signs

As a rule the adhesions lie at the mid part of the medial collateral ligament. The signs are: full extension hurts at the inner side; flexion is 5° or 10° limited; full lateral rotation hurts; full medial rotation is painless. There is no warmth to be felt and no fluid in the joint unless the patient is seen on the day of, or after, some exertion. The resisted movements are painless. Valgus strain hurts; testing the lateral ligament causes no pain and stretching the cruciate ligaments sets up no discomfort either. Tenderness is sought and found at some part of the medial ligament.

If a full range of movement is found, and localized discomfort together with a history of a former strain nevertheless suggest adhesions about a ligament, tenderness should be sought at the femoral origin of the medial collateral ligament if valgus strain hurts, but at the coronary ligament if valgus strain proves painless.

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8 TORN MENISCUS

History

The characteristic features are (*a*) locking *in flexion*, and (*b*) manipulative *unlocking* The first injury leading to rupture of the meniscus nearly always takes place between the ages of sixteen and thirty If a child of, say twelve has signs of cartilage trouble, the condition to be suspected is a congenital discoid meniscus, more often the lateral. If a patient is aged over thirty when he first fractures his meniscus, the disorder is usually an incomplete posterior crack.

Tearing of a meniscus is caused by a strong rotation strain. In the course of violent exertion, very often a game of football, the knee is severely twisted, usually in an attempt by the player to kick sideways, for his whole body is made to turn while the knee is fixed by the foot on the ground. It is this rotation strain of body on leg that fractures the intra articular meniscus of the knee the player is standing on He feels a click and a sudden agonizing pain in the joint, which gives way under him, making him fall to the ground. A minute later when, recovering he tries to move his knee, he finds that he can bend it a little but not straighten it either he, or one of his friends, or a medical man, forces it, and, with a click, full extension is regained After this the knee swells and is painful for a few days Later still when the patient has recovered, he finds that he is apt, if twisting on his knee once more, to feel something ' go out " painfully in his joint whereupon the leg gives way under him and he falls with the knee locked again in the semi flexed position. He then kicks his leg out straight or has it manipulated and suddenly the obstruction slips away and his knee becomes once more serviceable. Occasionally the layman's attempt at immediate reduction proves too painful to be borne , if so a medical man and general anæsthesia are called for

The side of the knee on which the patient felt the pain indicates which meniscus was torn the medial meniscus is much the more commonly torn of the two (various surgeons' figures give the proportion as three, five or seven to one) If a lesion of the lateral meniscus is present, it should be recalled that rupture is only twice as common as cyst formation Cyst at the medial meniscus is a great rarity

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Stieda-Pellegrini's Disease

After an apparently ordinary strain of the inner side of the knee, the range of movement is found not to be increasing but actually to have diminished. Examination reveals the lesion to lie at the medial collateral ligament at its upper extent. By a month after the injury, radiography shows a linear shadow along the whole inner side of the medial femoral condyle. Recovery in slight cases takes at least a year, in severe cases some disability may be permanent.

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In posterior meniscal cracks occurring for the first time between the ages of thirty and forty-five the history is less dramatic. The patient states that if he twists on his knee quickly he occasionally feels something go out at the back of the joint with a click; he kicks his knee out straight, the knee clicks again and is at once serviceable Locking of sufficient degree to require reduction by another person or eventual excision is uncommon. Middle-aged patients describe an even slighter disorder when the crack merely causes a bifid posterior extremity to the meniscus. The patient says that rotation in flexion during weight-bearing (*i.e.* movement while squatting) gives rise to an uncomfortable click, remedied as he stands up by another click.

Signs

Anatomy. As the knee straightens, the fact that the curve of the femoral condyles follows a spiral comes into play. Hence, the anterior cruciate and collateral ligaments become taut in extension, approximating the articular surfaces until no more slack remains to be taken up; this mechanism and the posterior aspect of the joint capsule prevent extension beyond 180°. The coronary ligament holds the meniscus in place; force sufficient to rupture the cartilage must sprain the ligament first Indeed, coronary strain leading to rupture of the meniscus is analogous to strain on the fibular collateral ligament leading to Pott's fracture. When the meniscus splits, the coronary ligament holds the rim in place—the handle of the bucket—but the rest of the meniscus slips across the dome of the femoral condyle to rest on the other side, *i e.* displaced towards the centre of the joint (see Fig. 107). Here the displaced portion gets in the way and prevents the painless approximation of the articular surfaces that accompanies extension, but it does not interfere with flexion, since in this position the ligaments are relaxed.

Rupture with Displacement. The patient's gait is characteristic He hops into the room on one leg, the knee on the affected side held flexed and the limb medially rotated, the foot plantiflexed with the toes just touching the ground.

On examination the knee is found warm, full of fluid, and when extension is attempted a springy block is felt limiting

this movement by 5° or 10° Flexion and rotation may be painful at extremes, but are not limited in range As a rule this springy block entirely prevents the achievement of full extension. However, a posterior tear with displacement in middle age may just allow full, but very painful, extension

The patient knows which is the painful side of his knee, and thus tells the examiner which meniscus is torn. Cartilage possesses no nerves, hence it cannot of itself be tender The tenderness on the joint line in meniscal tears is dependent

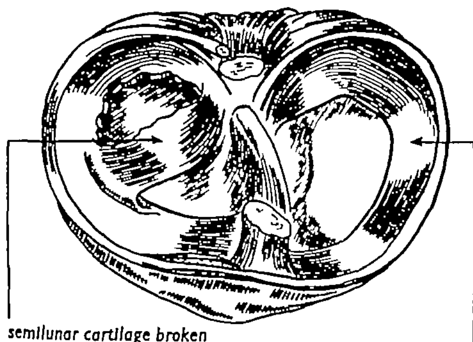


Fig. 107.—Torn cartilage at the knee. View from above showing tear with displacement of part of the medial meniscus. The lateral meniscus is intact.

on the coincident sprain of the coronary ligament. It is best sought by pressure from above downwards on the edge of the tibial condyle while the knee is kept flexed—the same position as for massage (see Vol II) In posterior cracks, no tenderness can be elicited Intra-articular cartilage has no access to blood hence the fracture cannot unite however long the broken surfaces remain in apposition. Thus, once the meniscus has ruptured, recurrence is the rule

Rupture without Displacement If the patient is seen some

time after an attack of internal derangement at the knee, the knee may appear normal. The history is often strongly suggestive, and the following tests can be used to elicit signs of a ruptured meniscus. (1) The knee is fully flexed and the knee rotated quickly to and fro A tell-tale click may be felt as the examiner's thumb presses on the front of the joint just above the tibia (2) The knee is flexed and fully rotated, first in one direction, then the other. It is then slowly extended while the pressure maintaining rotation continues.

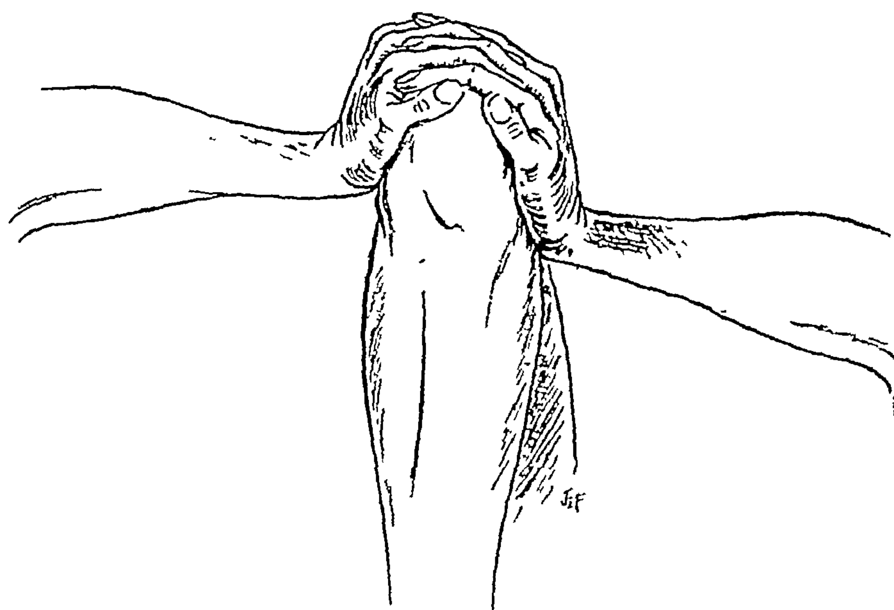


FIG 108 —Side-pressure at the knee A strong shearing stress is applied, first in one direction, then the other. As the femur and tibia move against each other, a torn cartilage may subluxate This is an accessory test for a meniscal tear

As extension proceeds, the possible range of rotation diminishes and a click may be felt as the leg approaches the neutral position at almost full extension (3) The knee is held at a right-angle. The examiner interlocks his fingers and places the heel of one hand on one side of the upper tibia, the heel of the other hand on the other side of the lower femur (see Fig 108). He then applies a strong shearing strain, as if to move the femur on the tibia laterally. He tries first one way, then the other. This manœuvre may displace the loose part of the meniscus to the other side of the femoral dome, with a loud click; simultaneously, the full range of passive

extension at the knee is lost. Manipulative reduction follows (4) The knee is held well flexed The examiner passes his flexed finger tip from above downwards over the joint line. He may be able to hook the rim of the meniscus and pull it downwards, then it jumps back into place again with a click.

These tests, particularly the last two, are repeatable at will Hence in doubtful cases they are most useful since they can be demonstrated *to a surgeon hitherto unwilling to operate* If all these tests prove negative, the patient should be sent back to full athletics, to ascertain if recurrence is thus provoked or not. If it is, the patient is asked to return at once, so that his knee can be examined again during the acute phase

4 LOOSE BODY IN YOUNG PERSONS

History

Loose bodies, often multiple, form in the knee-joint of young people as the result of osteochondritis dessicans, chondromalacia patellæ or chip-fractures The loose bodies have an osseous nucleus and thus show on the radiograph In osteochondritis dessicans, the gap at the inner femoral condyle whence the loose body arose is also revealed.

The history is that of locking *in extension.* The knee neither gives way nor is felt to unlock afterwards hence there is little resemblance to the sequence of events in meniscal tears. The patient states that, from time to time as he walks along the knee suddenly locks and tends to pitch him forwards on to his face since it is momentarily fixed straight just as he expects to bend it. He is halted in mid-stride, he may fall. When he tries to move his knee again, he finds he can move it quite well, and walks on. The knee aches and swells a little for a few days The pain may vary in position if as often happens, the loose body moves to another part of the joint

Signs

For a week or two after an attack of internal derangement, the knee is warm and contains fluid, and clinical examination reveals no localized lesion about the joint. Occasionally a

loose body can be felt moving about in the suprapatellar pouch. If the patella is pushed to one side and its posterior aspect palpated, the gap whence the loose body arose may be felt. Radiography is diagnostic.

Loose Body pressing on the Tibial Nerve. On rare occasions a loose body lying at the back of the knee-joint impinges against the tibial nerve. The patient complains of attacks suggesting internal derangement at the knee and also of intermittent numbness of the posterior two-thirds of the sole of the foot and of the second toe. Vague aching may be felt in the thigh.

The symptoms are abolished by manipulative reduction carried out at the knee

5. LOOSE BODY COMPLICATING OSTEO-ARTHRITIS

History

Whereas osteo-arthritis of the knee, unless gross, causes no symptoms, the fact that crepitating osteo-arthritis is present means that articular cartilage is damaged. A small piece may flake off; it would be interesting to know if the loose body originates from a meniscus or the articular cartilage itself. Such a loose fragment usually occupies a harmless position at the back of the joint; it may move however and come to lie impacted between the articular surfaces. The history is typical.

A middle-aged or elderly patient states that for no apparent reason swelling and *localized* pain has come on at one knee. He may wake up with it, or suddenly find that each step hurts while walking. The essential point is the absence of injury; for examination later gives rise to signs strongly suggesting a sprained knee. In fact, each time the patient bears weight on the knee, the presence of the impacted loose body sprains it. Thus the diagnosis is often suggested by the discovery of a traumatic arthritis which has come on without apparent trauma.

The pain is usually at the inner side of the joint; sometimes at the outer side; sometimes felt "right inside"; never all over; if it moves from one side of the joint to the other, the diagnosis is of course obvious. Sometimes the

pain spreads up the outer side of the thigh and down the leg in a way suggesting a sciatic distribution. The patient is afraid to go downstairs and takes a step at a time for fear of a sudden twinge and/or the knee suddenly giving way Such twinges and the same feeling of instability are experienced less often during walking they indicate momentary subluxations of the loose body Apart from a subluxating loose fragment of cartilage in an osteo-arthritic knee, the conditions that commonly give rise to a feeling that the knee may give way suddenly are (a) torn semilunar cartilage, (b) osteo-arthritis with loose body at the hip, (c) third lumbar root palsy, (d) recent transverse fracture of the patella, (e) partial ruptures of the quadriceps muscle, (f) neurogenic weakness of the gluteal or quadriceps muscles

Signs

These vary with the position of the loose fragment and may thus be difficult to interpret The knee is often warm to the touch, and warmer on the painful aspect of the joint than elsewhere. Osteo-arthritis is a cold degeneration of a joint, the mere presence of warmth proves that uncomplicated osteo-arthritis is not a sufficient diagnosis. If the joint is not found warm, the examination proceeds. At the end the palpation is repeated and it is often then noticed that the minor stresses imposed on the joint by examining its range of movement have given rise to local warmth, lasting only a minute or two Fluid is often present in the joint, whether it is warm or not. The following possible findings suggest an impacted cartilaginous body (1) Disproportionate limitation of movement. Naturally if extension is, say, 5° limited and flexion of full range, internal derangement is present. Again, if extension is full and painless but flexion, say 60° limited, the same applies. Such obvious findings are uncommon, but were in fact the signs that originally drew my attention to this hitherto undescribed condition. (2) Flexion at the knee is markedly limited, but it is localized pain, not the supervention of muscle spasm that restricts the range. In other words, the movement does not come to a characteristic stop it feels as if it will go the limiting factor is pain (3) Localized pain and warmth fluid in the joint, no synovial thickening—these clear signs of a sprained knee

7. HÆMARTHROSIS

History

The patient is usually an adolescent youth, with a minor tendency to hæmophilia. But an effusion of blood may result from injury without fracture in either sex; or come on, apparently spontaneously, in elderly men or women, perhaps as the result of rupture of an intra-articular vein.

The patient states that after a trivial injury, some overuse, or for no reason, the knee suddenly became very painful and swollen, filling up in a few minutes. The speed of appearance of the effusion and the severe pain by far exceed that caused by clear fluid, for blood is a strong irritant to synovial membrane.

Signs

The patient walks in on crutches, his knee bent up, unable to put foot to ground. The knee is hot and distended to its very utmost with fluid. Examination reveals 45° limitation of extension, 90° limitation of flexion. This limitation of movement is unaltered after some weeks in bed. Aspiration reveals the cause of the trouble at once. If hæmophilia is suspected, a vial of Russell viper venom for local application should be at hand in case oozing from the skin puncture proves troublesome.

8. INTRA-ARTICULAR ADHESION

History

This is a rare and remarkable condition. After what appears an unexceptional sprain or operation at the inner side of the knee (*e.g.* the removal of an osteoma at the medial femoral condyle), the knee progressively stiffens almost painlessly in spite of vigorous physiotherapy. The patient complains of inability to flex the knee, *e.g.* in walking upstairs; this increases as the days go by, but there is no discomfort to speak of. After, say, a fortnight, the knee retains 90° of flexion range; after a month, only 45°.

Signs

This uncommon disorder is brought to mind when, after an injury, the joint is found cold, not swollen, devoid of intra articular fluid, and yet on examination to have a full range of extension and 90° to 135° limitation of flexion The discrepancy between such gross limitation of movement and the absence of local articular signs is diagnostic. The radiograph does not reveal a Stieda Pellegrini shadow No amount of forcing without anæsthesia while the patient lies supine is effective. However, if the patient is turned to lie prone and the knee forced towards flexion (see Vol II) there is a loud sound as of tearing silk and full flexion is achieved at once

9 SUBSYNOVIAL HÆMATOMA

History

This is merely the result of a severe blow on the front of the thigh, just above the knee, followed by pain, swelling and disablement.

Signs

The knee is wollen and warm, if aspirated the fluid is often found blood-stained Extension is found to be of full range and only slightly painful, flexion on the other hand is at least 90° limited. Resisted extension is painless These findings indicate a localized articular lesion affecting the front only of the joint palpation reveals a hæmatoma lying between the femur and the suprapatellar pouch Aspiration, not of the fluid in the joint, but after passing the needle back wards till it reaches bone, confirms this diagnosis

10 POSTERIOR CAPSULITIS

History

The patient describes a severe sprain of the knee from which he has never fully recovered, the joint swelling and aching for several days after exercise The pain is behind or all over the knee, not on one side only as in a ligamentous injury

If this sign is found in middle age, it may be caused by osteo-arthritis affecting the patellar-condylar joint. An old stellate fracture leads to enlargement of the whole patella and incongruity of the opposed joint surfaces. Naturally, localized osteo-arthritis supervenes.

3. LESIONS OF THE QUADRICEPS BELLIES

History

The patient makes a correct diagnosis himself, stating that while running or jumping he was brought up short by feeling something give way painfully at the front of his thigh. Afterwards he could walk only slowly and with a limp

Signs in Minor Rupture

The hip-joint is found normal. The knee is normal on palpation; all movements are full and painless except flexion which is slightly or greatly restricted, depending on the size of the rupture. If the patient is asked to lie prone (thus keeping his hip extended) marked limitation of knee-flexion is found when the two sides are compared; for the upper end of the muscle remains taut in this position. Resisted extension of the knee hurts but is not weak. The tender area and the hæmatoma are palpable, usually at mid-thigh. This condition has been called "cricket-leg" and mistakenly attributed to rupture of the sartorius muscle.

Signs in Major Rupture

This occurs just above the suprapatellar tendon and may amount to complete separation. The swelling just above the knee is obvious, and palpation reveals the gap in the muscle. Resisted extension is very weak as well as painful; sometimes the patient cannot voluntarily straighten the knee against the mere resistance of the weight of the leg.

Adherence. When the belly of the quadriceps muscle has become adherent to the mid-shaft of the femur at the site of a fracture, limitation of flexion at the knee to 90° is a commonplace. The other knee movements are of full range—*i.e.* the extra-articular type of limitation of movement is present.

4 LESIONS ABOUT THE PATELLA

Fracture

A patient with a fractured patella may walk into the department complaining merely of pain in the knee following either a fall on to the front of his knee (stellate fracture) or indirect violence (transverse fracture) If the capsule enclosing the patella is not ruptured, displacement is avoided and disability is often slight.

Signs The knee is warm to the touch and contains fluid The passive movements are uncomfortable, but not limited Resisted extension is found markedly weak as well as painful. This association of articular with quadriceps signs shows that the lesion in the muscle overlies the joint, *i.e* affects the patella. Local tenderness and radiography are confirmative.

Tendinitis

This occurs at three sites at the suprapatellar tendon, at the quadriceps expansion to either side of the patella, at the infrapatellar tendon. The history is merely of pain felt on exertion at the front of the knee It is uncommon except in ballet dancers and the one-legged, who strain the patellar mechanism, especially on going downstairs.

Signs The knee-joint is found normal in every way only resisted extension proves uncomfortable. Palpation reveals the site of the lesion in the tendon

Apophysitis

Boys in their early teens may develop osteochondritis of the tibial tuberosity (Schlatter's disease) or, rarely, of the lower epiphysis of the patella. In either case, local pain elicited by a resisted extension movement is the only positive finding the site of tenderness is distinctive. The age of the patient should lead to radiography

DISORDERS OF HAMSTRINGS

When the knee-joint is found normal but resisted flexion of the knee hurts in the thigh a lesion of the hamstrings is

TREATMENT OF LIGAMENTOUS SPRAIN

The principle of treatment is the attainment of healing in the presence of adequate movement. This is achieved by methods differing according to the time that has elapsed since the accident.

Acute Stage

During the first twenty-four hours after a sprain, local anæsthesia is the treatment of choice. The site of the tear should be infiltrated with 3 or 4 c.c. of 0 5 per cent procaine solution as soon as the patient is seen. A thin needle one inch long suffices. The patient walks away. The next day he should attend for the treatment detailed below as suited to subacute sprain. This stage is markedly shortened when the patient is seen early enough for therapeutic anæsthesia. Further injections are not called for. Hydrocortisone will doubtless supersede local anæsthesia. It will be interesting to ascertain whether it suffices merely to inject the suspension into the knee-joint or if the best result follows infiltration at the site of the sprain itself.

The custom by which patients are rested in bed in the treatment of a recent sprain dies hard. This practice is largely responsible for the high incidence of chronic disability after injury to the ligaments at the knee. Moreover, later on, bonesetters reap the kudos attached to curing patients of the results of the treatment of sprained knees by rest. If the sprain is severe or the patient intolerant of discomfort, a few days' rest in bed may be called for. Even so measures to restore mobility passively should be instituted at once.

Subacute Stage

If a day or more has elapsed since the accident, deep massage should be given at once to the site of the minor tear in the ligament. This is essential in the case of the coronary ligaments, for they do not span the joint. Hence adequate movement cannot be imparted to them by merely moving the knee, and recovery is very slow if this method is adopted alone. But it is quite simple to move the ligament by drawing

the finger to and fro across it (see Vol II) indeed, this is the essential measure in coronary sprain Similar considerations apply to the tibial collateral ligament when traumatic arthritis prevents flexion at the knee-joint, the ligament cannot therefore be put through its full range Thus unwanted scars soon bind the ligament down. Friction imitates the normal behaviour of the ligament, moving it to and fro and hinders the formation of adhesions In either case the friction is followed by gentle forcing of movement, which is carried to the point of discomfort but not of pain. Deep massage allows a large increase in movement to be obtained almost painlessly each day The patient repeats the movements actively and is taught to walk slowly and carefully without limping Treatment should be continued until the range of movement at the knee is full and reached without discomfort

Treatment on these lines brings about recovery in as many weeks as orthodox treatment—which omits friction to the site of the tear—may take months

Chronic Stage

This stage is never reached if the patient receives adequate treatment early on.

The principle of treatment is to restore a full range of movement to the ligament by rupturing scar tissue binding it abnormally to bone. Deep friction to the affected part of the ligament moves it to and fro forcing movement by a sharp jerk completes the mobilization. General anæsthesia is occasionally necessary The sequence of events is illustrated in Fig 100 Intra-articular adhesion is treated by a special manipulation (see Vol. II)

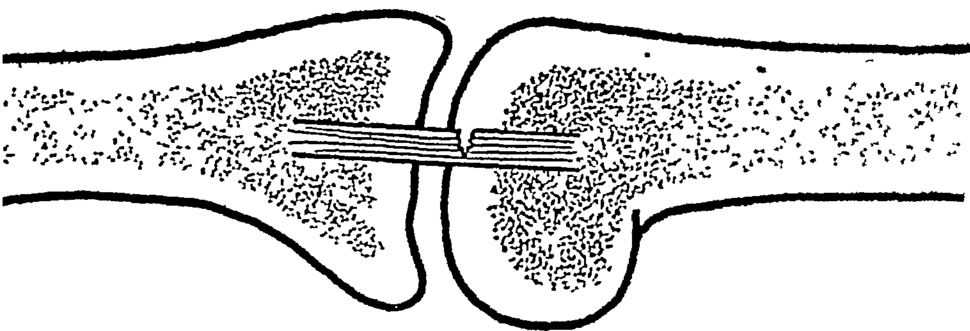
Lengthening of Ligaments

If this has occurred, permanent disability results After sprain of the cruciate ligaments, the knee should be spared all strains until the traumatic arthritis subsides this takes up to six months. Nothing can be done to hasten the long convalescence If permanent lengthening results in sufficient disability, an operation depressing the tibial spine and thus indirectly shortening the ligament is called for In minor

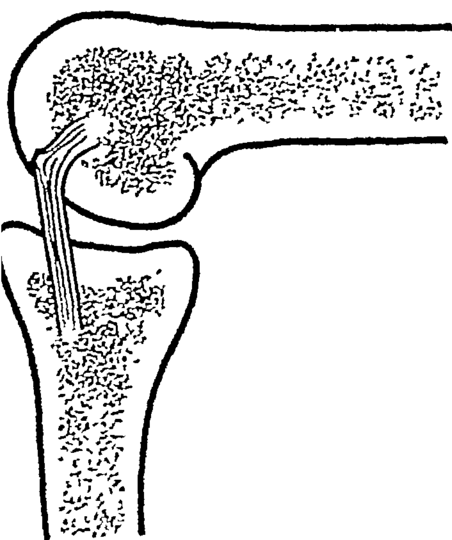
cases, continued strengthening of the quadriceps muscle helps to stabilize the joint. Lengthening of the medial collateral ligament gives rise to an increased range of movement towards valgus at the knee, but remarkably little disability, treatment is thus seldom required. Surgery has nothing to offer in Steida-Pellegrini's disease; the treatment is expectant.

TREATMENT OF EFFUSION

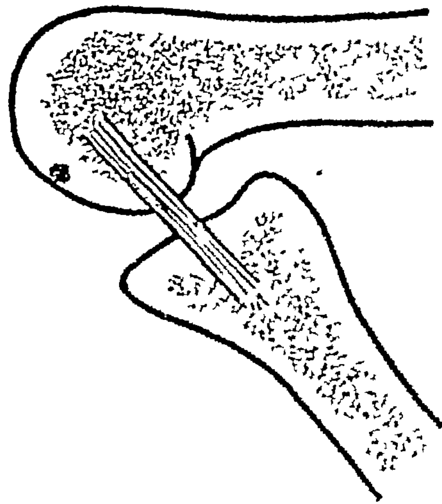
Blood in the joint must be aspirated at once, and the remaining blood-tinged synovial effusion aspirated again a few days later. Blood stays in the knee-joint for months,



(a) The patient rests with the knee held in extension. An adherent scar forms at the site of the tear, binding the ligament to bone and restricting mobility.



(b) Limitation of flexion results from scarring. As flexion proceeds the ligament becomes progressively deformed and over stretched.



(c) Forcing full flexion at the knee frees the ligament from its abnormal attachment and a full range of movement is restored to the joint.

FIG. 100.—Chronic sprain of medial collateral ligament (diagrammatic)

causing severe arthritis owing to its irritant proportion on synovial membrane. In suspected hæmophilia, Russell snake venom should be to hand in case the puncture in the skin oozes A subperiosteal hæmatoma lying under the suprapatellar pouch should also be aspirated, to obviate months of preventable disablement.

Clear fluid designates the presence of a lesion at the knee-joint, it is a result, not a cause. "Synovitis ' at the knee is thus a symptom, not a diagnosis. The treatment of a clear effusion is to discover its cause (e.g a sprained ligament) and treat that. Aspiration alone is useless.

An effusion into the prepatellar bursa makes it impossible for the patient to kneel. It should therefore be aspirated at once. If due to hæmorrhage, it seldom returns If a prepatellar bursa keeps filling up, and the provision of a soft rubber kneeling mat is ineffective, it should be excised

TREATMENT OF INTRA ARTICULAR DISPLACEMENT

The immediate measure is to reduce the displacement

Ruptured Meniscus

In the usual bucket handle tear it is the more deeply placed fragment that becomes displaced towards the centre of the joint, the superficial piece remaining in place on account of its continued attachment to the coronary ligament. The manipulation is therefore designed to allow the luxated fragment to slip back, over the dome of the femoral condyle, towards its proper bed. General anæsthesia is usually necessary, but it is often worth trying without first, especially in recurrent cases (see Vol II)

Splintage and conservative treatment after reduction are useless, since cartilage, having no blood-supply, cannot unite the after treatment is that of an acute coronary sprain.

Recurrent Dislocation of Meniscus

Bonesetters, in particular the late Sir Herbert Barker, claim to cure this condition. Very occasionally they succeed,

but not by causing the fractured surfaces to join; this is impossible. A really forcible manipulation may complete the rupture in the meniscus and force the loosened half into the intercondylar notch In this position, it no longer interferes with the articulating sufaces and if it stays there the patient has no more trouble, *i.e.* is "cured." But this happy result is secured only rarely and manipulation for recurrent dislocation is scarcely worth while. What bonesetters do in fact cure is chronic sprain, *i.e.* adherent scars, at the tibial collateral or either coronary ligament, and for the chronic stage of these conditions mobilization is indubitably the correct treatment. The question is one of diagnosis. Recurrent trouble at the knee with the tenderness "over the cartilage" (*i e.* of the coronary ligament) by no means necessarily implies that this has been torn, but accurate differential diagnosis is not unqualified practitioners' strong point. Hence the bonesetter may quite honestly believe that the symptoms relieved by him were due to such a tear. It is clearly undesirable, and to say the least a waste of time, repeatedly to manipulate a joint when there is every chance that it will have to be operated on in the end. Recurrent dislocation of either meniscus must be treated by excision. This is the only certain method of preventing the degenerative arthritis which results from the repeated severe sprains to which this accident subjects the joint.

Cyst formation at the meniscus can be treated by acupuncture; if the cyst contains fluid, cure may follow, since the puncture hole, being in cartilage, remains patent indefinitely. Should this simple treatment fail, the entire meniscus should be excised.

Loose Bodies

The one or more loose bodies that are found in young people's knees should be removed as soon as possible, since the more attacks of internal derangement the knee suffers, the worse for the joint in the end

Having an osseous centre, their position is revealed by the radiograph; since they may move, this should be taken immediately before the operation.

Impacted Loose ... *mpl* ... *teo-arthritis.* Such

loose bodies can seldom be found at operation for the position of the loose body, since it is wholly cartilaginous, is not revealed by radiography Being so small, I doubt if air arthrography would show it up either In any case, the patient's age and the degenerate state of his joint often preclude exploration Manipulative disimpaction must therefore be carried out as often as the loose body moves and causes symptoms. Manipulation as for a dislocated semilunar cartilage is unsuccessful, because this type of loose body does not move unless the joint surfaces have been separated first. Thus the main manipulation for this sort of displacement at the knee is performed during flexion (when the ligaments are relaxed) with traction (see Vol II)

Recurrence is apt to follow kneeling or keeping the knee well bent for some time, *e.g* sitting at the theatre. The patient should thus be warned not to flex his knee for long at a time.

TREATMENT OF PATELLAR LESIONS

Recurrent dislocation is treated by operation at which the infrapatellar tendon is shortened and re-sited at its tibial insertion.

Patellar femoral arthritis is best left untreated. In severe cases, the patella can be excised

The tendons above and below the patella and the quadriceps expansion along the side respond well to deep massage (see Vol. II)

TREATMENT OF ARTHRITIS

Osteo-arthritis causes no symptoms to speak of unless a fragment of cartilage gets loose and becomes impacted between the articular surfaces. If osteo-arthritis is gross enough of itself to cause symptoms, arthrodesis may be called for Alternatively, a moulded plastic knee-straightening splint can be worn.

Infective arthritis often clears up after two to four injections once a week of 10 mg of myocrisin directly into the joint. If this fails, intra articular hydrocortisone (25 mg every one or two weeks) is indicated and is effective, not only in the

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early case, but even after some years' increasing arthritis. In very advanced cases, immobilization is called for. If, in an advanced neglected case, the knee has become fixed in flexion, extension may be obtained by continuous weight-traction or under general anæsthesia, whereupon the limb is put in plaster for several months. In elderly patients in whom arthrodesis is inadvisable, such treatment may secure fibrous ankylosis in a good position. Manipulation under anæsthesia is contra-indicated if the radiograph shows such juxta-articular rarefaction of bone that fracture here is more likely than movement at the joint.

The arthritis that heralds spondylitis deformans responds well to hydrocortisone

CHAPTER XXI

THE LEG AND ANKLE

THE conditions that affect the leg are very simple. Diagnosis is seldom difficult. The only disorder that *commonly gives rise* to pain in the calf in the absence of a local cause is a primary postero-lateral protrusion of the nucleus pulposus at the fifth lumbar level (see p 419) The root pain is constant and remains unaltered by, *e.g.*, standing on tip-toe. This finding naturally suggests that the pain is referred to the calf from a lesion at the proximal end of the first sacral myotome.

Two conditions at the calf give rise to a characteristic history Intermittent claudication presents as pain in the calf coming on after the individual has walked a certain distance, disappearing as soon as he rests and recurring as soon as he has again walked for the critical distance In "tennis-leg" the pain in the calf comes on abruptly as the patient rises vigorously on tip-toe. During as a rule, a game of tennis, he feels a sudden pain resembling the lash of a whip at mid-calf and at once finds that pain prevents his putting one heel to the ground and that he has to hobble on tip-toe.

It must be remembered that the "growing pains felt in the legs both by normal and by rheumatic children give rise to no local signs. Constitutional signs and a raised erythrocyte sedimentation rate should be sought.

Examination of the bones and soft tissues is conducted in the following sequence

GAIT

This should be watched as the patient walks in

In children who fall easily a minor degree of spastic diplegia may be present. Various minor deviations from the normal of the lower limbs are often invoked to explain the child's instability—an idea that only inspection of gait corrects

THE BONES

Inspection reveals the shape of the bones; palpation discloses the nature of their surface.

Both tibiæ are curved inward at birth: the result of the ordinary intra-uterine position This bowing becomes gradually obliterated and by the age of two the tibia has straightened. Now knock-knees replace the previous bow-legs. This developmental genu valgum reaches its height at about four years of age and it is not until the age of six that the legs are once more as aligned as at the age of two.

In almost every child a slight outward rotation in the course of the tibia comes on during growth This makes the mid-line of the foot point slightly laterally to the sagittal axis of the knee. In consequence, adults "turn their feet out." However, this twist may become exaggerated If it is towards lateral rotation, the youngster is found bad at games; for, when the foot is not kept in line with the direction in which the individual moves, he loses an inch or two at every stride he takes Short calf-muscles and a plantaris deformity of the forefoot tend to force lateral rotation on the growing tibia. If the twist is reversed, both feet turn inwards. This is called "pigeon-toes," but it is a misnomer, since the deformity arises not in the foot but in the course of the tibia

Genu valgum in children persisting after the age of six is often the result of congenital inversion of the forefoot (see p. 628). Nowadays genu valgum due to vitamin-D deficiency is almost as rare as renal rickets.

A varus deformity of the tibia with rounding of its anterior edge occurs in osteitis deformans. The front of the leg is often warm. The patient is elderly and states the bowing to be of recent onset. Radiography confirms the diagnosis.

Traumatic periostitis of the subcutaneous surface of the tibia may prove rather obstinate, the patient presenting himself after he has forgotten the blow. He will, however, indicate the right place, where tenderness of the periosteum together with irregularity of its surface will be found. Sometimes fluctuation from effused blood can be elicited. Post-traumatic osteoporosis occurs (see p. 313). Syphilitic periostitis of the tibia is very rare nowadays. Dermatomyositis

shows itself as atrophic glossy skin attached to hard and immobile muscles preventing movement at the ankle-joint.

Treatment

So long as the child is not suffering from rickets, the tibia vara of babies and the genu valgum of young children should be left alone. Spontaneous rectification of the deformity is the rule. If the genu valgum results from inversion of the forefoot (see p 628), the latter must be dealt with energetically as soon as it is noted. Rotation in the course of the tibia can be corrected only by osteoclasis, which is best postponed until the child is at least eight years old. The subsidence of traumatic periostitis is hastened by deep effleurage Blood is absorbed very slowly from under the periosteum and is apt to leave thickening that remains tender for months. Aspiration is therefore called for if fluctuation can be elicited. No treatment avails in osteitis deformans, but butazolidine eases the pain

THE MUSCLES AND TENDONS

PAINFUL PLANTIFLEXOR MUSCLES

The muscles are examined next. First the patient stands and is asked to rise on tip-toe. Then he lies supine and plantiflexion, dorsiflexion, eversion and inversion are tested against resistance Note is made whether the movement is painful or painless strong or weak

If rising on tip-toe hurts, the calf muscles are at fault. In such cases the following test distinguishes between the soleus and gastrocnemius muscles The patient lies prone and plantiflexion of the foot is resisted, first with his knee fully extended, then while flexed to a right angle Bending the knee relaxes the femoral extremity of the gastrocnemius muscle but does not alter the strain on the soleus muscle hence abolition of pain when the movement is tested during knee-flexion incriminates the gastrocnemius muscle This is the rule since nearly all minor ruptures occur in the belly of this muscle.

Tennis-leg

This disorder has for years been regarded as a ruptured plantaris tendon, but the physical signs present at once show this ascription to be false. The patient describes sudden pain in the calf and hobbles in, tip-toeing on the affected side. Examination reveals pain on plantiflexion against resistance but no weakness. Dorsiflexion at the ankle is markedly restricted, owing to localized spasm of the muscle about the ruptured fibres. Bending the knee increases the range of dorsiflexion obtainable at the ankle; an instance of the constant length phenomenon. Were the plantaris tendon ruptured, the foot would not be fixed in plantiflexion nor would resisted plantiflexion be found painful. Palpation of the calf reveals either (*a*) a tender area in the gastrocnemius muscle, usually some two inches above the musculo-tendinous junction and rather to the inner side of the belly, or (*b*) in more severe cases, a palpable gap in much the same situation about half an inch wide.

Treatment. During the first ten days—the sooner after the accident the better—local anæsthesia should be induced as soon as the diagnosis is made. The right spot may not be easy to find, since gentle pressure is apt not to elicit tenderness and hard palpation to hurt everywhere. It is often best to acknowledge this difficulty from the start and use a 50 c c. rather than a 10 c.c. syringe, since several injections may otherwise have to be made. A successful infiltration is followed by the patient performing full active movements of the foot, *not* during weight-bearing. The next and following days the site of the tear in his muscle should be given deep massage (see Vol. II). Whether local anæsthesia is used or not, the patient should there and then be given a heel high enough to enable him to walk, taking weight on the injured leg. A cork platform covering only the heel should be put into his shoe; and if this is built up enough, walking can always be made possible. When sitting he should practise plantiflexion and dorsiflexion exercises at frequent intervals throughout the day. At each attendance the physiotherapist revises the height of the heel required to enable him to walk painlessly, lowering it as much as is compatible with comfort. When this treatment is instituted not later than the day after the

injury occurred, patients can expect to be playing tennis again at the end of ten days, without immediate active treatment the disability lasts for six weeks to six months or more Rest and over-exertion, as in all muscular injuries, are both equally harmful In chronic cases, scarring should be broken up by deep massage and mobility increased by stretching and exercises When a palpable gap exists in the muscle-belly, tip-toe exercises during weight bearing should be avoided for three weeks.

Teno-synovitis of the Tendo Achillis

The patient complains of pain at the heel, felt only during movement, and present ever since some unaccustomed exertion, perhaps in heel less shoes. He states that rising on tip-toe hurts the back of the heel

If, as is common, the lesion is a teno-synovitis, no movement hurts except resisted plantiflexion of the foot. The site of the lesion is usually at mid tendon and is quickly picked out by palpation Occasionally, the strain occurs level with the upper border of the calcaneus if so full plantiflexion of the foot squeezes the affected part of the tendon against the posterior aspect of the tibia hence this movement hurts slightly too If this movement hurts, but there is no pain on rising on tip toe, the bursa lying between the tendo Achillis and the bone is tender

Treatment. In teno-synovitis, a few sessions of deep massage are curative.

Teno-vaginitis of the Tendo Achillis

This takes three forms, rheumatoid gouty and xanthomatous.

Rheumatoid or Gouty Teno-vaginitis The contrast between the slight symptoms and the marked signs is striking The patient complains mainly of pain when his heel catches against an object. Examination shows that rising on tip-toe is scarcely uncomfortable. Yet the tendon is warm to the touch, swollen, and very tender There is no crepitus.

Hydrocortisone is the only effective treatment, except in gout when colchicum is indicated

Xanthomatous Teno-vaginitis. The tendo Achillis is a fairly common site for xanthomatosis. Both heels hurt during walking. Both tendons can be seen to be thickened and palpation reveals enlargement and a diffuse nodularity. The diagnosis becomes clear when similar nodules are seen and felt at the extensor tendons on the dorsum of both hands Occasionally similar swellings form on the tendons crossing the dorsum of the foot and on the bone at the upper part of the ulna and tibia

No treatment avails.

Intermittent Claudication

This phenomenon is dependent on the anatomical fact that two long arteries supply the gastrocnemius muscle. They follow its whole length, without forming anastomoses. This is a different pattern of blood-supply from: (*a*) the soleus muscle, which receives a number of branches entering at intervals all the way down; (*b*) the tibialis anterior and extensor hallucis bellies which are supplied by a series of anastomotic loops derived from a succession of vessels (Blomfield). Owing to this exceptional arrangement of its nutrient arteries, the gastrocnemius muscle is more susceptible than others to ischæmia as the result of arteriosclerosis. Claudication in early middle age suggests endarteritis obliterans; in youth, coarctation of the aorta. In the latter condition, the femoral pulse is lost

History. The history suggests the diagnosis In an elderly man the pain is brought on by exertion and relieved by rest. A similar history may be given by a patient with anterior herniation of the fifth lumbar disc (see p. 420), but standing still does not then relieve his pain, he must sit down. In early cases of claudication, the patient finds that walking some hundred yards brings the pain on, but that walking on further, no less than resting, abolishes the pain. In the former event, continuation of the stimulus to vasodilatation has clearly enhanced the flow sufficiently to prevent the products of muscular metabolism from remaining at a painful level. Later on, the symptoms can no longer be abolished by walking on; the patient is forced to rest each hundred yards or so to let the metabolites reach a concentration

below the threshold of pain. He can then walk on another hundred yards At this stage, pain at night is apt to begin, relieved by letting the limb cool outside the bedclothes When the muscles become warm, their metabolic requirement rises, just as it does during walking, to the point at which the possible arterial flow becomes inadequate.

Claudication is usually felt unilaterally If the state of the sural arteries enables a man to walk, say, a hundred yards with his left leg and a hundred and ten yards with his right, he never gets to the point of experiencing right sided claudication. Claudication may be regarded as beneficial if it is associated with angina, since it protects the heart from undue exertion by limiting exercise.

Intermittent claudication may rarely be felt at the front instead of the back of the leg Ischæmia of the muscles of the sole is a not uncommon cause of elderly patients' "foot strain."

Signs If plantiflexion is tested against resistance as the patient lies on the couch, neither weakness nor pain is elicited If he is asked to plantiflex and dorsiflex his foot quickly and repeatedly, the familiar pain is soon brought on Dependent, the foot is a dusky red, blanching on elevation Pulsation in the dorsalis pedis and posterior tibial arteries is usually absent on both sides.

Treatment Vasodilators should be prescribed Nicotinic acid in 50 mg doses three times a day after meals may enable a patient perhaps to double his walking distance. Tocopherol (vitamin E) in 100 mg doses four times a day continued for months is regarded as an effective treatment. Good results better than any yet attained by other methods, have been claimed for intra arterial injections of papaverine (Pemberton *et al.*, 1952) A raised heel gives the muscles rather less to do and the adoption of a steady slow pace brings requirement and supply closer to equilibrium If the symptoms warrant, the gastrocnemius may be divided at its insertion into the tendo Achillis. This leaves the soleus muscle, with its satisfactory arrangement of arteries, intact and is to be preferred to mere tenotomy of the tendo Achillis Denervation of the gastrocnemius is an alternative However all these methods may well be outdated by embryonic transplant. This has been done on several of my patients with the happiest results.

Physiotherapy and Buerger's exercises are not of appreciable assistance. Sympathectomy warms the foot but seldom increases the walking distance materially.

Nocturnal Cramps

These waken elderly patients and can be most troublesome They may have some connexion with disc-lesions for they are often initiated by a sciatica and are felt on the affected side only. In other cases, no cause is discernible. They may be a most troublesome sequel to section of the posterior root at the fifth lumbar or first sacral level (Sicard and Leca, 1954). The patient can sometimes precipitate an attack of cramp in the calf by stretching his leg out fully. Patients describe a ball of contracted muscle that travels along the belly, and the various positions in which the limb is fixed during the attack; one common one is extension at the knee, plantiflexion at the ankle and extension at the toes. Such a position involves co-ordination between several groups of muscles and must therefore be initiated centrally. I regard cramp as caused by an epilepsy of the anterior horn cells of the spinal cord. The connexion with disc-lesions is obscure.

Quinine diminishes the excitability of skeletal muscle by increasing its refractory period (Harvey, 1939). Five grains taken at bed-time should be continued for some months, after which it may be found that the tendency has passed and discontinuance does not lead to relapse. If it does, the patient should try out for himself the minimum dose that prevents the cramp Should quinine fail, mephenesin usually succeeds.

WEAK PLANTIFLEXOR MUSCLES

Painless weakness is best detected by asking the patient to stand on each leg in turn and rise on tip-toe Apart from upper motor neurone lesions, peroneal atrophy and direct injury to the sciatic nerve, the common cause of weakness unaccompanied by increase in pain when the calf-muscles contract is a fifth lumbar disc-lesion causing a first sacral palsy.

Rupture of the Tendo Achillis

This simple condition usually remains undiagnosed until too late, cursory examination resulting in its being dismissed

as some sort of sprained ankle. The patient states that while playing say squash, his foot gave way painfully The pain was momentary but he found at once that he could only hobble on a flat foot. He limped home and sent for his doctor who examined him as he lay on a couch. Active plantiflexion was found not to be lost Since the plantaris, flexor longus hallucis and digitorum muscles all remain intact, the supine patient can voluntarily plantiflex his foot Had the movement been tested against the slightest resistance, gross weakness would have been revealed. The pain and fixed equinus of a patient with a minor tear in his gastrocnemius muscle contrast with the absence of pain, inability to plantiflex strongly and excessive dorsiflexion range at the ankle characterizing rupture of the tendo Achillis When the patient lies prone, the defect in the tendon is easy to feel, a half to three-quarter inch gap is palpable at or slightly above the middle of the tendon

Treatment If the rupture is discovered within ten days of the accident, contracture of the calf muscles is not yet too great to prevent operative suture. After this period has elapsed, spontaneous organization of the hæmatoma with eventual fibrous repair should be awaited This takes several months. As soon as he is seen the patient should be given active exercises without weight bearing to his calf muscles, but told not to make any effort to rise on tip-toe for three months. Massage to the thickened tissues at each side of the enlarged tendon appears somewhat to ease the symptoms For the rest of his life, the tendon remains twice the breadth it originally was the fibrous swelling at the point of rupture never disappears and some residual disability is permanent This may amount merely to some aching towards the end of a round of golf, but other patients are lastingly unable to run, or to walk any distance without pain

SHORT PLANTIFLEXOR MUSCLES

Shortening forms part of a talipes equino-varus deformity in babies. If the equinus position of a baby's feet can be overcome by strong resistance, diplegia is present. In some children the calf muscles are short as an isolated phenomenon, it usually escapes detection In due course the mother

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complains of the child's gait, mentioning his feet, not his calves, hence routine exercises (including tip-toe) are usually prescribed and increase the deformity

The mother notices that the youngster turns his feet out too much, stands tilted backwards and runs conspicuously slower than his fellows. If, as is common, a *plantaris* deformity of the forefoot complicates the short muscles, he cannot bear adequate weight on his heels and mid-tarsal hypermobility and, later, painful strain result.

Examination reveals that dorsiflexion at the ankle-joint is painlessly limited to the horizontal line—what is often well described as equinus to 90°—since the calf-muscles will not stretch further.

Treatment of Equinus Deformity

In children, the treatment is temporarily to provide the shoe with a raised heel to protect the mid-tarsal joint, and to teach the following exercises. For stretching the soleus muscles: the child should perform a knee-flexion exercise barefoot, keeping the heel on the ground. For stretching the gastrocnemius muscle: the patient stands with the foot fully dorsiflexed at the ankle by pressure against a wall, the heel remaining on the ground; he should then lean forward vigorously keeping the knee in full extension. When the calf-muscles have lengthened, the raised heel on the shoe can be discarded again.

In adults, the *process of stretching out the calf-muscles* is too tedious, and shortening can be adequately compensated for by raising the heel of the shoe and increasing the obliquity of its upper surface. Elongation of the tendo Achillis by subcutaneous tenotomy followed by six weeks' immobilization in a plaster cast is sometimes called for.

THE DORSIFLEXOR MUSCLES

The strength of dorsiflexion on the two sides is compared; pain on this movement is noted. Normal dorsiflexor muscles easily overcome the examiner's resistance. This movement elicits pain in lesions affecting the anterior tibial and extensor longus hallucis and digitorum muscles. A resisted extension

movement of the hallux and then of the toes picks out the offending muscle.

Myosynovitis of the tibialis anterior muscle is an interesting condition, with only one other parallel in the body—myosynovitis with crepitus of the bellies of the abductor longus and the extensores pollicis muscles in the forearm It is an uncommon disorder except in army service, when recruits march unaccustomed distances in boots. The resisted dorsiflexion movement hurts at the front of the ankle further



FIG. 110.—Pes cavus. The foot is short and broad. The extensor tendons of the toes stand out holding the toes clawed. The toes have corns and a large callosity has formed under the metatarsal heads.

testing shows the long extensor muscles of the digits to be unaffected, and palpation fails to reveal any tenderness of the anterior tibial tendon. If the examiner now puts his finger on the outer aspect of the junction of the middle with the lower third of the tibia, crepitus on movement is felt at the musculo-tendinous junction of the anterior tibial muscle close to the bone, *not* where the tendon passes under the ligament.

At the ankle, teno-synovitis (sometimes with crepitus) of the extensor longus hallucis or digitorum is a rarity Shortening of these muscles complicates a pes cavus deformity eventually fixing the toes in the clawed position (see Fig 110)

partment (see p. 584) the nerve may be compressed where it pierces the fascia at mid-leg. If so, pins and needles are felt at the big and second toes.

THE INVERTOR MUSCLES

These are the anterior and posterior tibial muscles If a resisted inversion movement hurts, and dorsiflexion does not, the posterior tibial muscle is at fault. The tendon is palpated throughout its extent until the site of the lesion is found.

Treatment. A posterior tibial tendinitis caused by ordinary overuse gets well with a few sessions of massage. It is often secondary to a valgus deformity at the heel, especially if the cause is fixed inversion of the forefoot. Such cases continue for years. They are curable only by a combined approach: a support to correct the lack of parallel between hindfoot and forefoot (see Fig. 125) combined with massage to the affected extent of tendon (see Vol. II). Neither measure suffices alone.

POST-OPERATIVE VENOUS THROMBOSIS

Every effort should be made to prevent this serious disorder: for pulmonary embolism may be fatal and femoral thrombosis often leads to permanent œdema, ulceration and recurrent phlebitis.

The first site where the veins become affected is usually in the calf. Thrombosis starting in the posterior tibial veins may spread to the femoral and iliac vessels. When the calf-veins are affected alone, slight fever begins and the pulse-rate rises steadily. Passive stretching of the calf-muscles by dorsiflexion of the foot causes discomfort; most patients make no complaint of pain when left lying still.

A minor pulmonary embolism may cause merely some hours' pleural pain; the patient may complain of "stitch." A day or two later he may cough up a little blood-stained sputum. Such a patient is in great danger of a massive embolus and anticoagulants should be given immediately. Some surgeons recommend immediate ligature of both superficial femoral veins as well.

Gross femoral thrombosis is obvious. The leg resembles

white marble, is distended to the utmost and cold to the touch Though the primary lesion is venous, the limb is cold owing to arterial spasm, maintained by sympathetic tone.

Prophylaxis

This begins in the operating theatre, where the patient's heels should be supported on a sandbag so that his calf muscles are not compressed during the operation itself When the patient recovers consciousness, the physiotherapist who visits him to give breathing exercises should see to it that he also contracts and relaxes his calf muscles at regular intervals from the first. Early post-operative rising much diminishes the incidence of posterior tibial thrombosis

Treatment

Heparin and dicoumarol were the two anticoagulants in everyday use, they are being displaced by tromexan

In femoral white leg the sympathetic supply to the artery must be blocked at once. Though direct infiltration of the paravertebral ganglia is not easy, a high epidural injection is simplicity itself One hundred c.c. of 0 5 per cent procaine reaches to the first and second lumbar levels and blocks the rami communicantes. The improvement is immediate and, once the femoral artery has relaxed, it tends to stay so

THE ANKLE-JOINT

This is a simple joint allowing of movement in only one plane plantiflexion and dorsiflexion. The range of dorsiflexion is limited by the length of the calf muscles. These are at their most extensible in young children in whom the dorsum of the foot can be laid against the leg with ease Plantiflexion is limited by the engagement of the heel, via the tendo Achillis, against the back of the tibia The talus is held in place by the tibio-fibular mortice, which in turn depends on the inferior tibio-fibular ligament for its effectiveness

the ankle merely feels sore for a day or two afterwards. The cause is permanent lengthening of the inferior tibio-fibular ligament.

When the ankle-joint is examined, nothing is detected at first, but when valgus and varus movements are tested at the talo-calcanean joint, the click is reproduced at the ankle when varus is forced. If this movement is repeated with the examiner's fingers palpating the two malleoli, they can be felt to move apart, and if a radiograph is taken while strong varus pressure is exerted at the heel, the increased distance apart of the lower ends of tibia and fibula is seen. The bones must be wired together again.

SPRAINED ANKLE

"Sprained ankle" is the general name for a variety of traumatic lesions occurring at what the layman calls his ankle Several conditions may legitimately be described under this heading; each may exist alone, but combined lesions predominate. Moreover, one structure may recover, leaving chronic disability due to another.

Sprained ankle may be classified according as the causative stress is towards varus or valgus, and according to the length of time that has elapsed since the accident.

VARUS SPRAIN

This is as common as valgus sprain is uncommon. The stresses imposed on the tarsus by a varus sprain are: (1) plantiflexion at the ankle-joint, stretching its outer side and the extensor longus digitorum muscle; (2) varus at the talo-calcanean joint, stretching the outer side of the capsule, the fibulo-calcanean ligament and the peroneal tendons; (3) medial rotation and adduction at the mid-tarsal joint, stretching the outer aspect of the calcaneo-cuboid joint-capsule. Exceptionally the cubo-fifth-metatarsal or cubo-navicular joints or the plantar fascia suffer as well. Thus, injury to one or more of these structures may well be described by the patient as a sprained ankle.

Examination in Varus Sprain

This must include

1 Passive movements at the ankle-joint.
2 Passive movements at the talo-calcanean joint.
3 Passive movements at the mid tarsal joint.
4 The resisted movement appropriate to each of the tendons that span the tarsus

Deduction of the site of the lesion is drawn from the pattern that emerges when these passive and resisted movements are tested Once the site of the sprain has been outlined by this examination, tenderness of the appropriate structure is sought. In recent severe cases, gross oedema often gives rise to such generalized tenderness that palpation yields no information, if so the diagnosis is arrived at purely by inference from a study of the response to these movements The affected sites, in order of descending frequency, are

(a) The fibular origin of the fibular collateral ligament of the ankle (b) the talar insertion of this ligament (c) the outer fibres of the calcaneo-cuboid joint-capsule (d) the lower extent of the fibulo-calcanean ligament, (e) the peroneal tendons (f) the tendon of the extensor longus digitorum. The commonest lesion is a combined sprain of the fibular collateral ligament and the capsule of the calcaneo-cuboid joint.

If examination shows the tendons to be affected as much as, or more than, the ligaments, the customary treatment of a sprained ankle by early ambulation is inadvisable. The patient should rest as much as he can for a few days until massage has cleared up the tendinous strain

Treatment of Varus Sprain

This depends on the time that has elapsed since the accident.

Acute Stage During the first twenty four hours after a ligamentous sprain hydrocortisone or local anaesthesia is indicated at once The necessity for an accurate diagnosis is now obvious, since the infiltration has to be performed at some definite point. Deep effleurage is a great aid to precision for, after the physiotherapist has removed the greater

interested in the fact of cure than the nature of the lesion and prefers the bonesetter who made a wrong diagnosis and put him right to the doctor who made a correct diagnosis but was unable to help him. No after-treatment is required.

Chronic teno-synovitis requires deep massage to the affected part of the tendon. Until well, the patient should avoid such exertion as causes pain.

Recurrent Varus Sprain

The patient states that his ankle turns over easily; it lacks stability and is thus subjected to a succession of minor sprains. The recent case should be treated on the lines set

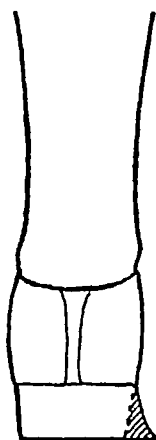


FIG 112—Heel floated at outer side. For recurrent varus sprain of ankle

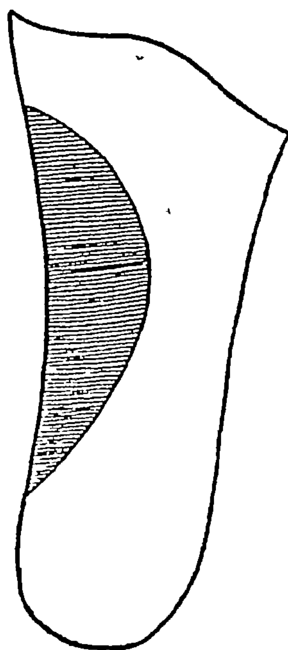


FIG. 113—Valgus support. The thickness lies at the inner side of the mid-tarsal joint

out above. Repetition is best prevented by floating out the heel of the patient's shoes (see Fig. 112) and by increasing the strength of the peroneal muscles by resisted exercises and, if necessary, faradism.

If the examiner can reproduce the sprain at will, with an

audible click as varus is forced at the heel, lengthening of the inferior tibio-fibular ligament should be suspected (see p 589)

If the peroneal muscles are found weak, it must be remembered that at times the first complaint in upper motor neurone lesions is recurrent varus sprain at the ankle.

VALGUS SPRAIN

When this rare condition is encountered the foot should be examined in an endeavour to discover why the stress took the unusual direction. As a rule the patient is found to stand with a valgus deformity of his heel and abduction of the forefoot. Hence, every time he puts his foot to the ground he overstretches the damaged tibio-navicular or tibio-calcanean ligaments. For this reason, sprains of the anterior and middle fasciculi of the deltoid ligament are apt to go on hurting for many months, even some years, since the patient strains the ligament anew at every step

Treatment

This is twofold. The heel and forefoot must be so supported that strain during weight bearing is removed from the affected fasciculus. To this end a support is prescribed thick at the inner aspect of its calcanean and mid tarsal extent (see Fig 113) When this is fitted, the calcaneus assumes the neutral position during weight bearing (thus relaxing the tibio-calcanean ligament) and the cessation of abduction of the forefoot spares the tibio-navicular ligament Deep massage to the affected areas of ligament now hastens cure, but is ineffective unless the support is fitted first. Manipulation is contra indicated

The posterior tibial tendon is often affected as well. If a resisted inversion movement hurts, the affected area of tendon must be given massage too

CHAPTER XXII

THE FOOT

THE patient can usually point accurately to the site of a lesion in the foot. Pain is hardly ever referred to the foot only; indeed referred symptoms nearly always identify themselves by being felt diffusely about the lower part of the limb.

Examination

Examination of the joints and muscles of the foot comprises: (1) inspection; (2) testing the passive movements at the ankle-joint: dorsiflexion and plantiflexion; (3) testing the passive movements at the talo-calcanean joint: varus and valgus; (4) testing the passive movements at the mid-tarsal joint while the heel and ankle joints are held still: plantiflexion and dorsiflexion, medial and lateral rotation, adduction and abduction; (5) testing the passive movements at the metatarso-phalangeal and interphalangeal joints; (6) testing the resisted movements: plantiflexion, dorsiflexion, eversion, inversion of the foot, and flexion and extension of the toes

After the foot has been examined with the patient lying, it should be inspected again while the patient stands. The general posture of the foot, and the changes in shape caused by weight-bearing, are noted. If the standing examination is carried out first, the physician does not yet know what is the matter with the foot and he cannot yet assess the significance of alterations in shape and colour.

It is quite possible for a foot to hurt and yet to appear normal on clinical examination. This implies that the momentary stress imposed by manual testing of various movements does not suffice to evoke pain; in other words that the strain would have to resemble that of maintaining the body-weight for some time to be adequate. In such cases, inspection of the shape of the foot, and of the changes it undergoes when bearing weight, shows where this undue strain develops

and by corollary where it must be reduced Inspection of the patient's worn shoes is often a help in showing where he bears most weight. Moreover it reveals whether they suit his foot or not

THE HEEL

The conditions giving rise to pain at the heel can be grouped under eight headings.

1 TRAUMATIC PERIOSTITIS AND FRACTURE

Blows on either side of the calcaneus may set up a traumatic periostitis at its subcutaneous surfaces, subsidence of the swelling and pain is hastened by deep effleurage. Minor flaking or cracks are uncommon and require no treatment More severe fractures give rise to local pain and tenderness associated with bruising at the anterior part of the sole and necessitate up to two months complete avoidance of weight bearing Fractures involving the surface of the calcaneus articulating with the talus set up a painful and intractable arthritis. Arthrodesis is better performed early than late, for disabling symptoms continue indefinitely

2 SUBCUTANEOUS NODULES

Posteriorly nodules may form in the subcutaneous fascia. When these get pinched between the calcaneus and the back of the shoe, severe pain results. On examination, tender nodules the size of a small pea can be felt slipping to and fro under the examiner's finger No conservative treatment avails except the provision of shoes whose uppers have a gap posteriorly Division of the nodules by subcutaneous tenotomy under local anæsthesia gives results as good as excision.

3 PLANTAR FASCIITIS

Overstrain

The patient complains of pain at the heel when walking and standing relieved at once by the avoidance of weight

bearing. During normal standing the shape of the foot is partly maintained by the muscles; prolonged weight-bearing tires the muscles which eventually prove unequal to the stress. Strain, soon becoming painful, then falls on the plantar fascia instead.

Examination of the joints and muscles of the foot draws a blank. Tenderness is sought and found at the inner part of the front of the calcaneus, at the origin of the plantar fascia. Various other spots are palpated first, to ensure that psychogenic symptoms are detected.

Calcanean Spur

Continued overstrain of the fascia may result in the periosteum being pulled away at its origin from the calcaneus.

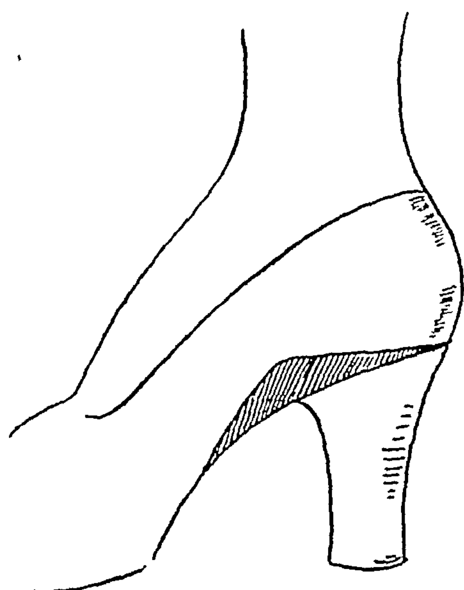


FIG. 114.—Platform. The upper surface of the heel of the shoe is rendered horizontal by a wedge, thicker anteriorly. The plantar fascia is relaxed, because the forefoot drops into greater plantaris.

Since periosteum is the limiting membrane of bone, the gap becomes filled by new growth of bone as also occurs in osteophyte formation at the lumbar joints. The fact that the patient has, or did at one time have, strain on his plantar fascia now becomes visible on radiography. The presence of a calcanean spur on the x-ray photograph cannot determine whether the patient has symptoms or not. Spurs may

develop painlessly painful plantar fasciitis may not be associated with a visible spur Once a spur has formed, it is permanent hence radiography may disclose spurs the pain from which ceased years previously If history and clinical examination show painful strain to exist at the origin of the plantar fascia, radiography is of no particular assistance.

Treatment. This is very simple, spur or no spur it consists in taking the *strain off the plantar fascia.* The less the angle between hindfoot and forefoot, the more the fascia is relaxed. Hence, all that need be done is to stand the patient on wooden platforms of different thickness until the minimum height of heel that abolishes the symptoms is found Provided the upper surface of the heel of the shoe remains horizontal, the higher the heel the more must the forefoot drop towards plantaris when he stands (see Fig 114) This shortens the distance from metatarsus to heel and relieves the fascia from strain. Thus, a height of heel can always be found that affords immediate relief Faradism and exercises to the short flexor muscles in the sole are now energetically pursued until their strength is once more *adequate to protect the fascia from undue stress.* The soreness leaves the fascia very slowly and it is often six months before a patient can return to his ordinary shoes without experiencing recurrence.

Occasionally, return to ordinary shoes provokes pain again each time it is attempted In a woman, this is not of much account, but a man may not wish to wear a raised heel indefinitely If so, a local anæsthetic or hydrocortisone may *be injected into the fascial origin Either is usually effective* The plantar skin is too thick to be capable of surface sterilization hence the puncture must be made at the thin skin at the inner side of the heel Alternatively tenotomy of the fascial origin at the calcaneus is called for followed by six weeks immobilization in *plaster Exercises for the short flexor* muscles are carried out in plaster from the first. It is a very successful little operation

Superficial Plantar Fasciitis

The pain is felt all over the posterior part of the sole, usually bilaterally Curiously enough, the pain may be

constant, felt even in bed, though worse during weig
bearing.

Examination shows the whole inferior surface of the heel
be uniformly tender, including the half-inch round the edge
the heel that does not touch the ground.

The only effective treatment appears to be an injection
10 c.c. 0·5 per cent procaine between the superficial plan
fascia and the surface of the calcaneum The solution diffu
over the whole area forming a large tense swelling. T
patient walks away and is usually pain-free by some days lat
even after months or years of hitherto intractable sympton

Gonorrhœal Fasciitis

The pain is in both heels and is constant, unrelieved wh
the patient rests. The patient, if he is honest, admits to
recent attack of gonorrhœa. A few days in bed should
advised to avoid strain on the fascia while the prima
infection is being energetically treated.

4 TENDINOUS LESIONS

These will merely be enumerated, having been dealt wi
in the previous chapter.

- Teno-synovitis of the tendo Achillis from overuse (se p. 577).
- Teno-vaginitis of the tendo Achillis due to rheumatoi disease or xanthomatosis (see p. 577).
- Strain of the tendo Achillis at the teno-periosteal junctio (see p. 577).
- Rupture of the tendo Achillis (see p. 580).
- Teno-synovitis of the peroneal (see p. 584) and posteric tibial tendons (see p. 586). Mucocele of these tendon (see p. 585).

5. BURSITIS

A bursa is normally present between the tendo Achillis anc
the tibia. If it is tender, pain is elicited when it is squeeze
between the tendon and the tibia at the extreme of passiv
plantiflexion at the ankle. Bursitis is distinguished fron

lesions of the tendon itself by the fact that rising on tip-toe is painless One or two injections of hydrocortisone are curative

An adventitious bursa may form between the skin and the posterior aspect of the calcaneus in women who wear shoes too incurved at their upper edge posteriorly The back of the shoe must be altered and a rubber pad can be introduced at the lower half of the back of the calcaneus, keeping the upper half away from the shoe. Excision is seldom necessary

Another bursa may form centrally at the inferior aspect of the calcaneus It lies superficial to the mid part of the origin of the plantar fascia A heel support scooped out centrally is required

6 LESIONS OF THE FIBULO-CALCANEAN LIGAMENT

Sprain

This is one of the possible lesions in a sprained ankle The varus movement at the talo-calcanean joint is of full range and painful the valgus movement full and painless Tenderness is usually confined to the lower half of the ligament, and friction is given to this point in the standard way

Rupture

This is signalled when an excessive range of varus movement is found on testing the talo-calcanean joint. Strapping (see Fig 108) should be applied holding the joint in valgus and kept on for a month By then, the ends will have united. Associated lesions are dealt with in the ordinary way, but varus movements must be avoided.

If a recent rupture passes unnoticed, permanent lengthening of the ligament results for which the patient must wear a floated heel (see Fig 112) indefinitely

7 LESIONS OF THE TALO-CALCANEAN JOINT

The joint allows movement in only two directions—varus and valgus.

Talipes Equino-varus

A varus position of the calcaneus on the talus forms part of the club-foot deformity. Correction and the maintenance of correction by Denis-Browne splintage should be instituted as soon after birth as possible.

Immobilization

Marked limitation of movement results from the immobilization imposed on the tarsal joints by the treatment in plaster of some tibio-fibular fractures. The joint is stiff, but there is no muscle spasm when the joint is forced.

Mobilization of the joint is technically difficult, whether performed manually or under anæsthesia by means of a Thomas's wrench, because the small size of the calcaneus affords very little purchase to hand or wrench. Many months' forcing bring their reward eventually. Restoration of a full range is not essential; a slightly limited range is compatible with good function.

Osteo-arthritis

This follows fractures of the calcaneus involving the surface articulating with the talus. Intractable pain results, curable only by arthrodesis.

Subacute Traumatic Arthritis

Recovery after a sprained ankle is unduly delayed. Examination shows limitation of both varus and valgus movement at the talo-calcanean joint maintained by muscle spasm. The mid-tarsal joint is usually affected as well. Local warmth is often detectable if the patient has recently walked some way.

Three to six months in plaster leads to full recovery, unless (as is alas quite common) the ankle has been manipulated under anæsthesia on account of a mistaken belief that post-traumatic adhesions required rupture. Such manipulation gives rise to severe pain and disablement which subside only after one to two years' immobilization in plaster. Patients in whom such a subacute traumatic arthritis has

been exacerbated by manipulation are often regarded as hysterics, but the heel is fixed in valgus in organic and in varus in psychogenic disturbances

Infective Arthritis

There is no history of injury and the disorder is often bilateral. In addition to limitation of both varus and valgus movements by muscle spasm, local heat and synovial thickening are palpable. The mid tarsal joint is usually affected as well. It is a rheumatoid manifestation, often accompanied by the typical changes in other joints. In young men gonorrhœa and spondylitis deformans are possible alternative causes, in elderly men, gout should not be forgotten.

If the symptoms warrant, immobilization in plaster is indicated and often has to be maintained for twelve to eighteen months.

8 CALCANEAN APOPHYSITIS (OSGOOD)

Between the ages of six and twelve years, apophysitis may occur, often bilaterally The bone is slightly tender and the radiographic appearances characteristic. I have seen one child in whom a piece of radio-translucent glass lying against the periosteum gave rise to what had at first appeared to be an apophysitis. Spontaneous recovery occurs in the course of a year or two, often with the development of a slight permanent prominence at the posterior aspect of the calcaneus

THE MID-TARSAL JOINT

The talo-navicular and calcaneo-cuboid joints comprise the mid tarsal joint. Movement is possible in six directions dorsiflexion and plantiflexion, adduction and abduction, lateral and medial rotation. On account of the obliquity of the joint surfaces dorsiflexion at the mid tarsal joint is accompanied by abduction of the forefoot with consequent stretching—often painful—of the calcaneo-navicular ligament. Hence excessive dorsiflexion strains on the mid tarsal joint are to be avoided

When movement at the mid-tarsal joint is tested, the heel must be pulled down and held still. This precaution prevents movement at the ankle and talo-calcanean joints from complicating the clinical picture.

Five different conditions affect the mid-tarsal joint.

1. MID-TARSAL STRAIN

If power in the musculature of the sole becomes insufficient to maintain a sufficient degree of plantaris of the forefoot during weight-bearing, the mid-tarsal joint-capsule becomes painfully strained This is particularly likely to occur in patients who have an over-arched foot or an equinus deformity at the ankle. In such cases weight-bearing dorsiflexes, and therefore abducts, the forefoot at the mid-tarsal joint; this stretches the capsule, the calcaneo-navicular ligament and the plantar fascia. At first the plantiflexion-dorsiflexion range of movement is greatly increased and the foot becomes wobbly; later on discomfort (mid-tarsal strain) appears, pain being elicited at the extremes of passive range, especially rotation.

Treatment

This consists of three measures: (1) raising the heel of the shoe, so as to allow the forefoot to adopt a plantaris position during weight-bearing; (2) exercises (faradic and resisted) to the short flexor muscles in the sole so that they shall become adequate to take the strain and thus relieve tension on the capsule of the joint; (3) mobilization of the mid-tarsal joint, so as to ensure that the full range of movement can be achieved painlessly. Though an excessive range of movement is found at the joint, repeated strains, followed by healing, of minor capsular ruptures have led to the formation of adhesions. This is [illegible] only example in the body of manipulation being cal[illegible] a joint wh[illegible] already possesses an excessive r[illegible]ement. A[illegible]nd-ance for faradism and [illegible] the phys[illegible] also forces movement at the [illegible]larly r[illegible] all the extremes of range [illegible]ss.

2 MID-TARSAL OSTEO-ARTHRITIS

Unless gross and the result of fracture or of an old navicular apophysitis (Köhler) osteo-arthritis causes no symptoms It results in osteophytes visible and palpable at the dorsum of the foot and equally visible on the radiograph. Osteo-arthritis at the mid tarsal joint is largely a misnomer, based on a mistaken application of radiological appearances If the capsule of the joint is strained—whether osteo-arthritis



FIG. 115—Steel support. This is accurately moulded to the sole of the foot and prevents as far as possible all movement at the tarsal joints.

shows on the radiograph or not—the treatment for mid tarsal strain applies. If gross disturbance of the anatomy of the foot has really led to marked osteo-arthritis causing symptoms, a steel support moulded accurately to the sole of the foot (see Fig 115) minimizes movement as far as possible at the disorganized joints. Arthrodesis is a last resort.

3 SUBACUTE ARTHRITIS IN ADOLESCENCE (SPASMODIC PES PLANUS)

This disorder has for years been known as spasmodic pes planus because the most obvious sign is spasm of the muscles, but muscle spasm is never primary In this the spasm results from arthritis, and is not spasmodic, intermittent, but continuous. The name is misleading should be abandoned.

An overuse-arthritis occurs almost exclusively in between the ages of twelve and sixteen. The talo and mid tarsal joints of both feet are affected Little or no pain results, the patient's mother is

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An overuse-arthritis occurs almost exclusively in boys between the ages of twelve and sixteen The talo-calcanean and mid tarsal joints of both feet are affected together Little or no pain results, the patient's mother is usually the

complainant. The boy stumps in with a clumsy gait and is found either to have a long thin foot or to be overweight and possess some degree of pes cavus—in other words, a foot so shaped as to be easily overstrained.

The condition is not common except in districts where a large number of factories exist and boys fresh from school are put to work (*e.g.* at a lathe) that entails standing all day. Such overuse, rarely a single sprain, is the ætiological factor. On examination valgus deformity of the heel and abduction deformity of the forefoot are seen to be maintained by spasm of the peroneal and extensor longus digitorum muscles. When the patient stands the tendons are seen to stand out as a prominent tight band behind and above the lateral malleolus. Passive inversion at the heel and tarsus is prevented by muscle spasm. When muscle spasm limits movement at a joint, arthritis is present. This generalization applies to the talo-calcanean and mid-tarsal joints as much as to any other. A valgus position of the heel and abduction of the forefoot during weight-bearing do not suggest this uncommon condition unless muscle spasm restricts movement at, or fixes, these two joints. The radiograph reveals no abnormality.

Left untreated, the slight symptoms cease at the end of two years and the foot becomes permanently but painlessly fixed in the deformed posture. An ungainly gait results; *that is all. No troubles ensue in later life.*

Treatment

Early Case. Movement at the joint has not been entirely lost and the patient experiences discomfort on standing for some time but walking is painless and there is no aching in the absence of weight-bearing. The essence of treatment is relief from weight-bearing and support for the joint.

The lad therefore requires (*a*) a sedentary job, (*b*) a bicycle, (*c*) a wedge on the heels of his shoes and (*d*) strapping of the joint. He is told never to stand for one instant if he can help it. If he sits at home, sits at work and travels everywhere on a bicycle, weight-bearing can be all but completely avoided. Nevertheless he remains able to get about satisfactorily.

The heels of his shoes are fitted with inner wedges; these

tend towards a varus position of the calcaneus Non-elastic strapping is applied freshly each week to support the affected joint The strapping should be put on while the foot is held at a right angle and as far over towards varus as possible. First the strapping is fixed to the inner aspect of the lower leg then carried round the mid tarsus, then fixed to the outer aspect of the lower leg during strong traction (see Fig 116) The patient is kept under observation and in the course of six to twelve months usually regains a full range of movement and loses his discomfort. Recurrence is improbable.

Late Case There is no movement at the talo-calcanean joint which is fixed by peroneal spasm in the position of valgus, little or no movement is possible at the mid tarsal joint.

The leg and foot should be encased from below the knee to the toes in a plaster cast while the foot is held in the varus position In most cases this position can be attained by blocking the peroneal nerve at the point where it winds round the neck of the fibula The nerve trunk is identified by palpation and local anæsthesia induced Paralysis of the peroneal and extensor longus digitorum muscles results and the bar to a varus movement is thus abolished The plaster cast is kept on for six weeks, whereupon it is removed and the measures indicated for the early case instituted

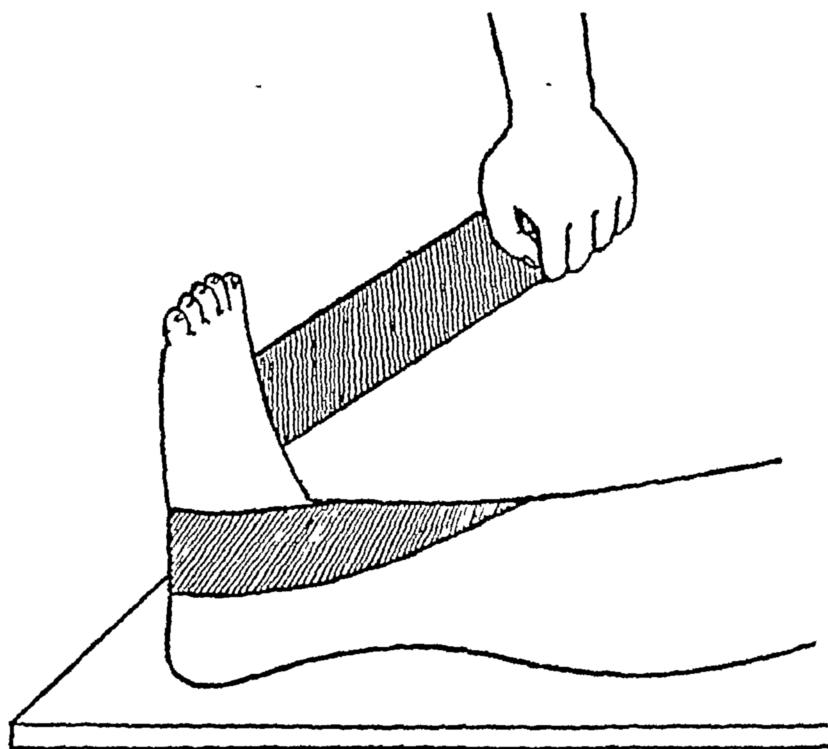
If paralysis of the evertor muscles does not allow of movement towards varus, structural contracture of the capsule of the talo-calcanean and mid tarsal joints has taken place The decision must now be taken whether to let the deformity remain in the knowledge that it will eventually become painless but remain unsightly, or to attempt wrenching under general anæsthesia, followed by putting the foot in a plaster cast in a good position In the latter case, the treatment is continued as above The former alternative is to be preferred

4 SUBACUTE ARTHRITIS IN MIDDLE AGE

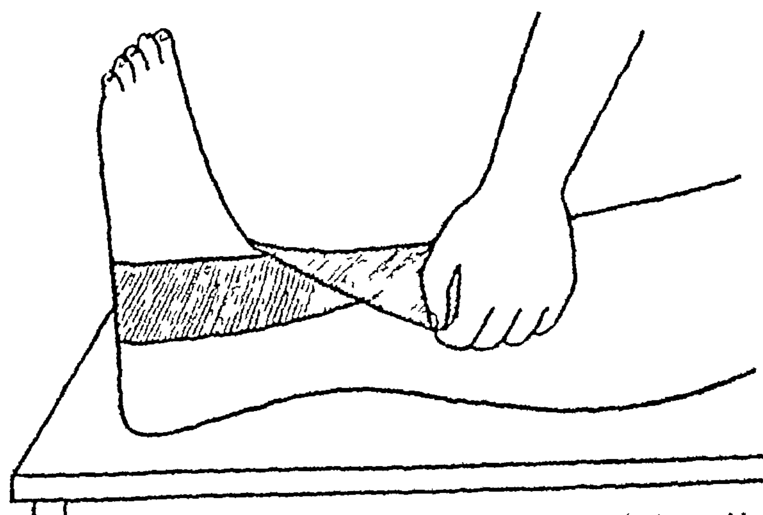
The patients are usually stout women The muscular spasm and limitation of movement are less pronounced than in adolescence Overuse is a much commoner cause than an isolated sprain. Examination reveals that muscular

spasm partly restricts an inversion movement at the talo-calcanean and mid-tarsal joints, usually unilaterally. The radiological appearances are normal.

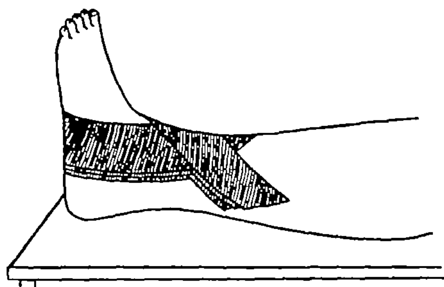
Treatment by rest, tilting the heel and strapping in the



(a) The foot is held at right-angles to the leg The strapping is applied first to the inner side of the leg, and is brought round the outer side of the mid-tarsus



(b) Strong tension is exerted as the strapping is applied to the inner side of the mid-tarsus and fixed to the outer side of the leg This inverts the forefoot as much as possible.



(c) Three layers of strapping have been applied.
FIG 116.—Strapping for mid tarsal joint.

varus position nearly always lead to eventual subsidence of the arthritis. Cases that have lasted for two or three years are not uncommon, in default of treatment the condition appears to continue indefinitely without altering much. Six months of this modified rest are usually required for some years afterwards the patient should guard against renewed overuse.

5 INFECTIVE ARTHRITIS

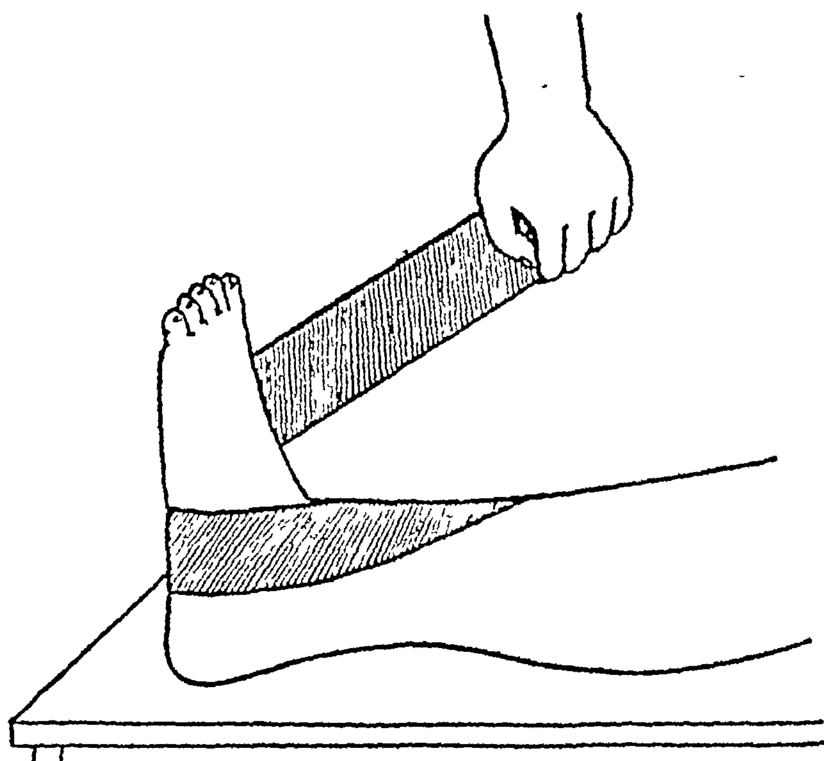
Arthritis, usually bilateral, sets in for no apparent reason at the talo-calcanean and mid tarsal joints. If the arthritis is at all severe, the patient can scarcely hobble a few steps and attends hospital in a wheel-chair Sleep is disturbed

In severe cases the foot is markedly œdematous, warm to the touch and movement at these two joints is very much restricted If the œdema allows, synovial swelling is palpable at the dorsum of the foot. The usual cause is a rheumatoid type of disorder, but in young men gonorrhœa and spondylitis deformans should be considered, and in elderly men gout.

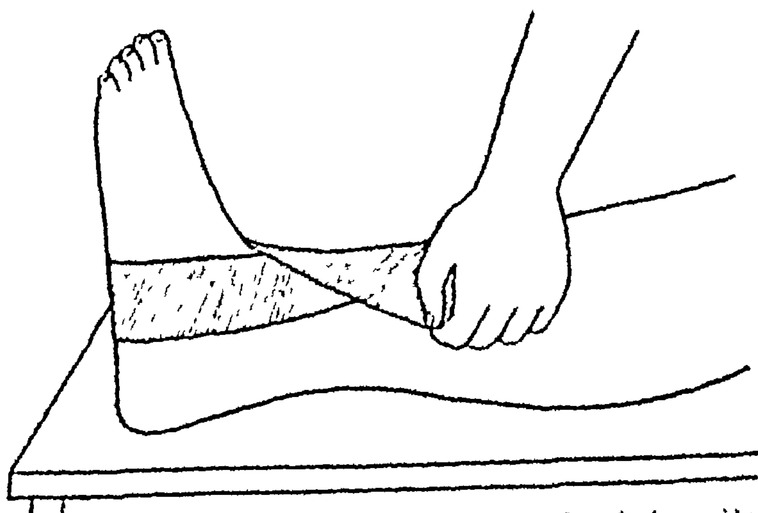
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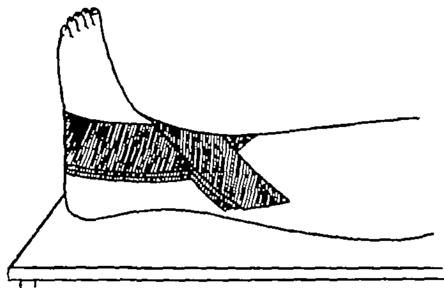
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Immobilization in a plaster cast is called for at once in infective arthritis. This is followed within a few days by complete relief from pain, the patient being able to walk

short distances without discomfort. He can return to sedentary work. The plaster cast has to be kept on for at least a year. In practice the patient requests its removal or it becomes loose after some months; in either case the pain returns and another cast has to be applied. Cure usually takes one or two years to attain. If not, rather than let the patient continue indefinitely in pain, I recommend arthrodesis.

THE CUNEO-FIRST-METATARSAL JOINT

Osteophytes at this joint are often seen in adolescents. Osteo-arthritis here is a remarkable phenomenon; for it clearly has a constitutional cause, since it comes on without trauma and is bilateral; yet it never results in any other joints becoming similarly affected.

The onset is usually insidious. The patient, usually a girl, finds that if she wears shoes that lace tightly across the dorsum of her foot, localized pain comes on at the site of a small bilateral projection. Palpation reveals this to be an osteophyte at the cuneo-first-metatarsal joint; radiography can be used to confirm this obvious fact. Rarely the onset is acute; both joints become tender and swollen. When at the end of a week the arthritis has subsided, the girl finds that she has a small prominence on each foot that was not previously present. The final condition of the joint is the same, whichever way it began.

The condition is wholly benign. Recurrent pain is due only to the pressure of the shoe squeezing the skin against the osteophytes, and for that reason easily avoidable.

Rarely gout may attack this joint before any other; the diagnosis may then be uncertain at first.

Treatment

While the arthritis is acute, a few days' rest should be advised, with weight-bearing only in a high-heeled court shoe, no part of which touches the joint. Mobilization towards full flexion has been tried during the acute stage; it has the curious result of affording full relief for about twenty-

four hours, after which, for some days the pain is made worse than before. Spontaneous recovery from the pain is a certainty The avoidance of pressure on the now prominent joint, and wearing a heel high enough to make the plantiflexion deformity innocu ous, keep the patient's foot com fortable. A felt ring about the bony outcrop enables the girl to wear lace-up shoes.

It is important that the patient should not be told without adequate explanation that she has arthritis ' in her feet. This sounds most alarm ing to patient and parents, who, when the onset is so early in life, naturally envisage eventual cripple dom

Osteo-arthritis of the cuneo-first metatarsal joint may lead to fixation of the joint with considerable plan taris deformity This may in turn result in metatarsalgia affecting the first metatarso-phalangeal or the sesamoid metatarsal joint. If so, a support (see Fig 117) must be pre scribed taking weight off the head of the bone.

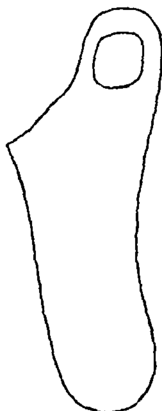


Fig 117 —Support for sesamoiditis. The hole in the support corresponds to the first metatarso-phalangeal joint.

THE METATARSAL SHAFTS

SHORT FIRST METATARSAL BONE

Much is made of atavistic shortening of the first metatarsal bone. In my experience, such shortening is compatible with full painless function of the foot, and the cause of pain should be sought elsewhere.

MARCHING FRACTURE

The feature that should bring this condition to mind at once is unilateral localized warmth and œdema lying in a

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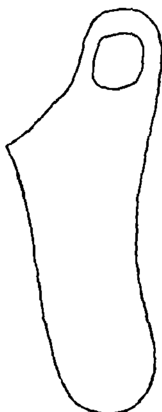
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The feature that should bring this condition to mind at once is unilateral localized warmth and œdema lying in a

circular patch over the metatarsus. The condition has been ascribed to "fatigue" of the bone, and may occur rarely at other parts of the skeleton. As a rule, there is no history of injury or of an audible crack, not even always of excessive walking.

Children are almost as liable to marching fractures as adults; the youngest patient to come my way was aged six.

Examination during the first fortnight after the pain began reveals: (*a*) local warmth; (*b*) œdema over the dorsum of the forefoot; (*c*) tenderness of the metatarsal shaft and of the interosseous muscles on each side of it. Clearly the two halves of the bone cannot move on each other without markedly stretching these muscles (*cf.* fractured rib). The tenderness is therefore more diffuse than is to be expected from the fracture as such, and it is not always easy to decide which of the metatarsal bones has broken. The fracture is most often at the neck of the second or fourth metatarsal bone but may lie anywhere. Stress fractures appear not to occur at the first and fifth metatarsal bones

After two or three weeks, the tumour caused by callus becomes clearly palpable, especially when the distal part of the shaft has broken. Diagnosis is then easy, and may be confirmed by radiography. Since appreciable displacement does not occur, and no callus is visible during the first two or three weeks, and the tiny crack may not show on the radiograph of a recent case, it is well to wait until the end of the third week before having the photograph taken.

Abortive cases occur, in which the periosteal reaction round the neck of the bone is indicated by a faint fusiform shadow, visible to one side only of the bone. Such an appearance suggests a crack not extending through the whole shaft, but the condition is none the less painful for being partial.

Differential Diagnosis

Circular elevation on the dorsum of the foot caused by a tendency to œdema and a shoe with a narrow strap across the dorsum may be seen, but this is bilateral, painless and not warm.

Localized warmth, swelling and tenderness at the dorsum

of the distal part of the foot occur in (a) Gout. The recurrent history in an elderly man is suggestive, the skin over the joint may be slightly red (b) Gonorrhœa, when the rheumatoid type of response has occurred. (c) Rheumatoid arthritis. This is usually multiple, and the history too long A marching fracture recovers spontaneously in six weeks. (d) Freiburg's arthritis of the second metatarso-phalangeal joint (see p 620) (e) Ringworm. If a small crack exists between two toes owing to infection with the fungus, local cellulitis may set in with swelling, warmth and reddening at the dorsum of the foot. Inspection of the interdigital clefts makes the diagnosis clear (f) Morton's metatarsalgia. If a patient with this disorder is seen within a few hours of an attack, the vascular reaction that follows gives rise to local warmth but no œdema. (g) Tuberculosis. This is a rarity at a cuneo-metatarsal joint. Swelling and warmth were present in the one case that I have encountered, but there was no œdema. Doubtless sarcoma would lead to warmth and swelling too In such cases the radiograph is diagnostic.

Treatment

The bone is firmly enough united to be painless in six weeks, whether the fracture was partial or complete Malunion need not be feared There is no necessity for the patient to stop walking during the period of union, his forefoot should merely be firmly bound to diminish movement at the fracture and to enable the other metatarsal shafts to splint the broken bone. Even so, weight bearing is bound to hurt a little, it is up to the patient to do as much as he will in these circumstances.

Persistent pain after the six weeks have elapsed originates not at the fracture but at the interosseous muscles, strained by the abnormal stresses. They should receive treatment by deep massage, faradism and exercises. Full recovery seldom takes longer than a fortnight.

SPLAY FOOT

When this causes symptoms, these are due to painful over-stretching of the transverse interosseus ligaments whereby the metatarsal bones are given excessive horizontal

play. Other conditions, particularly weakness of the short flexor muscles of the toes, are usually also present. Such weakness should be treated energetically and the foot bound.

Localized splaying indicates a tumour lying between two metatarsal heads. When the patient stands, an excessive interval is seen between two toes and palpation reveals that a semi-solid tumour keeps them apart. Since the tumour is thick and loculated, often being made up partly of fibro-lipomatous material, attempted aspiration seldom diminishes its size or the patient's symptoms. Excision is indicated if the symptoms warrant.

THE TOE-JOINTS

THE FIRST METATARSO-PHALANGEAL JOINT

This joint is normally capable of 30° of flexion and 90° of extension; the latter movement is the important one. As he walks, an individual has to extend the big toe of his hinder foot to at least 45° when his other foot goes forwards Hence osteo-arthritis remains painless until half the range of extension has been lost.

Arthritis in Adolescence

In a youngster aged fifteen to twenty, large osteophytes form at the dorsum of both first metatarso-phalangeal joints. Patients are nearly always male. The onset is slow and unprovoked by overuse or injury. At first, some correction is possible by the development in such young patients of hyperextensibility at the interphalangeal joint. Within a few years a hallux rigidus has developed, and pain at every step due to bone being forced against bone at the dorsum of the joint is inevitable.

Examination shows a fixed big toe, little or no extension remaining, and gross dorsal osteophytes.

Conservative treatment consists in the prescription of a rocker (see Fig. 118) whereby the patient can adopt a normal gait, pivoting over the rocker instead of forcing his osteo-arthritic joint. If this does not suffice, operative removal of the base of the proximal phalanx is indicated. Alternatively

a steel sole prevents movement at the metatarso-phalangeal joint, but the gait is less natural

Arthritis in Middle Age

Osteo-arthritis at the first metatarso-phalangeal joint comes on between the ages of forty and sixty sometimes a heavy weight falling on the joint starts the degeneration. Symptoms start when only 45° of extension range remain Since aggravation is slow, no symptoms may arise for years.

Treatment. If, for some urgent reason, the patient wishes to be relieved instantly of pain brought on by too much walking, traction should be given. The foot is fixed and a

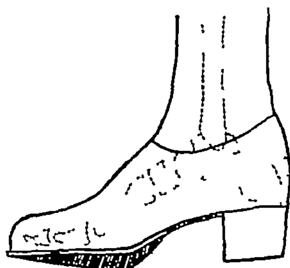


FIG. 118.—Rocker For the relief of hallux rigidus. Instead of extending at the first metatarso-phalangeal joint, the forefoot rocks over the thickened sole.

Japanese finger-stall applied to the hallux. Twenty pounds traction applied for twenty minutes is a normal treatment and stops the immediate pain To prevent recurrence a rocker is fitted to the sole of the shoe (see Fig 118) Alternatively a strong spring can be incorporated in the sole of the shoe, lying at the medial side and extending from the waist to the anterior end of the sole. This impedes extension at the affected joint.

Gout

This occurs typically at the big toe in elderly men The attacks are unprovoked, recurrent and for at least some

Since they cease to flex the toes properly at each step, excessive weight is repeatedly thrown on to the metatarso-phalangeal joints instead; pain results

4. *Result of wearing High Heels.* In all ready-made shoes, high heels possess an oblique upper surface. The patient



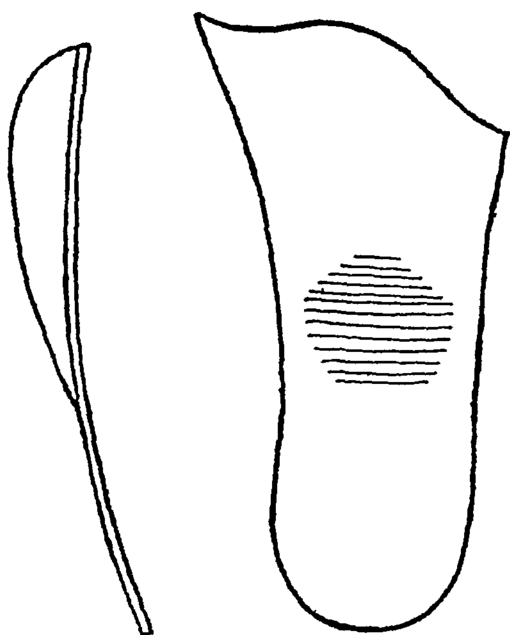


FIG 120—Support for metatarsalgia The thickness lies just behind the heads of the metatarsal bones, the shafts of which are thus made to bear the greater weight

stands on an inclined plane, sliding down on to her forefoot all the time. High heels whose upper surface is horizontal, or nearly so, are free from this defect and can be worn with comfort by all women with a plantaris forefoot.

Treatment. The principle is the avoidance of excessive weight-bearing at the forefoot. Active and passive measures can be taken. The former consist of so strengthening the short flexor muscles of the sole by means of faradism and exercises that the toes flex properly at every step and do not tire after standing or walking. Prophylactic foot-

exercises after a long stay in bed or a debilitating illness are an obvious precaution. Passive measures consist of the provision of a support (see Fig 120) that stops short just behind the heads of the metatarsal bones and ensures that the



(a) Note how the central part of the sole of the foot is out of contact with the shoe, and how the pressure of the heel on an inclined plane pushes the body weight on to the forefoot. (b) Note how the shoe fits the sole of the foot and how weight bearing on the heel is devoid of forward stress.

FIG 121 — Shoes with (a) oblique heels and (b) horizontal heels.



FIG 122.—Dancer's metatarsalgia. Semilunar anterior support making the proximal phalanges of the three middle toes bear more weight.

shafts of these bones bear more weight than the joints themselves A heel whose upper surface is horizontal hinders the foot from sliding forwards and enables weight to be borne on the hindfoot as well as the forefoot (see Fig 121)

Dancer's Metatarsalgia. A dancer who does a lot of tip-

toe work (not *sur les pointes*) may bruise the fibrous tissues of the sole lying anterior to the second, third and fourth metatarso-phalangeal joints. When this happens, he must be made to bear more weight at the plantar surface of the toes. To this end his ballet shoes are fitted with a small semilunar pad (see Fig. 122) which ensures that the joints are spared as much weight as possible.

Chronic Metatarsalgia due to Structural Change

Osteochondritis of the Head of the Second Metatarsal Bone. This disorder was first described by Freiburg in 1914 and bears his name. I have not met a patient who was less than fourteen years old at the onset. The lesion presents as a localized arthritis of the second metatarso-phalangeal joint. Local swelling and warmth are present, together with limitation of flexion and extension at this joint. At this stage only the radiograph distinguishes the condition from a marching fracture. Since it takes a month from the onset of pain for the characteristic radiographic change to begin to show at the head of the bone, and it often takes three weeks for a marching fracture to become radiographically visible, differential diagnosis is difficult during the first few weeks.

Spontaneous recovery from the subacute arthritis takes a year. At the end of that time, the joint recovers an adequate range of movement, but the head of the bone is permanently enlarged. Palpation reveals the increase in size and a prominent ridge on the bone at the dorsal aspect of its articular edge. Metatarsalgia due merely to the bony enlargement ensures. This usually necessitates the wearing of a support (see Fig. 120). In due course, osteo-arthritis supervenes and, by the time the patient is forty or fifty, the joint may become fixed in a manner analogous to hallux rigidus. In such cases excision of the metatarsal head may become necessary.

Rheumatoid Arthritis and Gout. In advanced cases, the toes may become fixed in the clawed position. Metatarsalgia is bound to result, largely relievable by a support.

PRESSURE ON NERVES AT THE FOREFOOT

Pressure on nerves causes acute twinges of pain. Hence the diagnosis is made largely on the history

BRUISING OF THE SECOND DIGITAL NERVE

This nerve passes forwards at the lateral side of the plantar aspect of the first metatarso-phalangeal joint, and can easily be palpated here as a thick strand It bifurcates just distal to the joint, supplying sensation to the adjacent borders of the first and second toes In view of its exposed position, it is surprising that it is so seldom injured Stepping on a sharp stone or a puncture wound at the place where the nerve crosses the joint may be followed by persistent bruising of the nerve In consequence the patient gets sharp painful twinges as he walks followed by a few seconds' pins and needles.

Treatment

The patient should wear a thick rubber pad under his forefoot for three to six months. This smoothes the impact of foot against shoe and may prevent the twinges. Local anæsthesia should be induced at once and repeated if necessary A long thin needle is introduced at the dorsum of the foot at the level of the metatarso-phalangeal joint and thrust in until it is felt to impinge against the plantar skin Ten c.c. are injected about the sheath of the nerve.

A neuroma requiring excision seems not to occur at the first interspace.

ACUTE METATARSALGIA (MORTON)

This condition was described by Morton in 1876 and before that by Durlacher in 1845 (Kemp 1949) The history is characteristic.

The patient complains that as he walks he is suddenly seized with agonizing pain at the outer border of his forefoot. He has to stop dead and stand on his good foot he takes his shoe off and rubs the painful area. After some minutes the pain ceases but the foot becomes warm and stays so for

several hours. When the pain has gone he is able to walk on comfortably. He may experience two attacks in a week then nothing for a year; recurrences are very variable but always appear in the end and tend to become more frequent. Between attacks, there are no symptoms or physical signs.

The disorder comes on between the ages of fifteen and fifty, and is much commoner in women. The ætiology of the disorder was first put on a firm basis by Betts (1940), who ascribed it to nipping between the bones of a fibrous swelling of the fourth digital *nerve proximal to its point* of division. Resection of the nerve proved curative. This view has been amply confirmed since. Though the fourth and fifth toes are usually those affected, an occasional case between the third and fourth toes is encountered.

Examination is wholly negative. An attempt to reproduce the attack by moving the heads of the metatarsal bones against each other during compression always fails. Cutaneous analgesia at the affected toes is absent. Palpation of the sole fails to reveal the tumour on the digital nerve. The diagnostic points are therefore: (*a*) the history of severe momentary bouts of pain at the outer forefoot followed by long periods of freedom, and (*b*) the absence of any discernible disorder at the foot.

Treatment

Conservative treatment consists merely in altering the alignment of the metatarsal heads If the nerve is nipped in the fourth interspace, the patient is prescribed a support

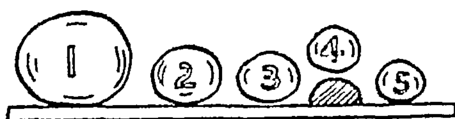


FIG. 123.—Support for Morton's metatarsalgia The small pad alters the alignment of the fourth metatarsal head on the fifth Painful nipping of the digital nerve is then obviated

elevating the head of the fourth bone (see Fig. 123). This keeps the bones slightly out of line and prevents pinching. Since it is arguable whether the swelling on the nerve is the cause or the result of a series of nippings, it may well

be that such a support prevents the later formation of the enlargement that aggravates the condition. Occasionally the patient finds this support uncomfortable and may prefer one supporting the third and fifth bones The effect is the same as regards the alteration in position of the fourth bone in relation to its neighbours—merely down instead of up

Should conservative treatment fail, the sole of the foot should be explored and the nerve with its neuroma excised

THE TENDONS OF THE FOOT

Disorders of the tendons are few and obvious.

A ganglion or a xanthoma may form at the dorsum of the foot in connexion with a tendon.

The extensor hallucis and digitorum muscles become shortened in pes cavus, leading to clawing of the toes, i.e fixation in extension at the metatarso-phalangeal joints and flexion at the interphalangeal joints. Tenotomy may be required Teno-synovitis of the extensor hallucis or digitorum tendons at the front of the ankle is uncommon it leads to pain elicited by resisted extension of the big or the four little toes Massage cures in a very few sessions In dancers gross crepitus is often present at the flexor hallucis tendon at its course at the back of the ankle It is due to overuse and, although the crepitus may even be audible, symptoms seldom ensue. If pain is provoked when the tendon moves, deep massage is rapidly curative Rupture of the flexor longus hallucis at its insertion leads to a flail distal phalanx and is an appreciable disability, for the big toe keeps catching when the patient walks without shoes Arthrodesis is required

A plantaris deformity of the forefoot may induce excessive weight bearing on the first metatarso-phalangeal joint This may irritate the joint between the head of the first metatarsal bone and the sesamoid bone in the flexor longus hallucis tendon. A support (see Fig 117) relieving this joint of stress is required

Weakness of the extensor hallucis muscle is a common result of fourth or fifth lumbar disc-lesions

metatarsal heads is achieved either by fitting a support that relieves this pressure, or by so strengthening the short muscles of the sole that the pads of the toes take enough weight. Pain and tenderness from a callosity usually cease after an injection of a local anæsthetic solution placed at the deep aspect of the affected plantar skin. The puncture is made dorsally, and the needle thrust through the foot until it is felt impinging against the upper surface of the callosity. Ten c c of a 0 5 per cent solution of procaine are injected. The patient walks away pain-free and usually remains so. Pinching the callosity transversely, previously most painful, becomes and remains devoid of discomfort. In a resistant case one exposure to x-rays is indicated.

To pare corns away is a very temporary expedient; unless the pressure that stimulates cornification is obviated, recurrence is certain. Corns are symptomatic of excessive pressure, and are not the cause so much as the result of pain. Hence the deformity to which they are secondary, usually a hammer toe, has to be dealt with (see p 629).

Plantar Wart (*Verruca*)

Epidemics occur in schools and the cause appears to be a virus infection. The warts are pale, often multiple, and the ring of hard skin round the central papilla is diagnostic.

X-ray treatment seldom fails, but it should be given only by an expert for fear of ulceration appearing later. For this reason a second course of radiation is apt to be dangerous. Chronic ulceration may not show itself for up to two years. Formalin baths are said to be effective.

ISCHÆMIA OF THE FOOT

In advanced arteriosclerosis, the circulatory defect may show itself at the sole rather than in the calf-muscles, particularly when the posterior tibial artery is affected. Alternatively the nutrition of the toes may suffer. Claudication occurring in the short flexor bellies is usually called cramp by the patient and comes on when the metabolic requirement is increased on walking or when the feet get warm in bed.

Inspection reveals the foot, especially the toes, to be a dusky red colour when the patient stands. The circulation returns slowly after an area of skin has been blanched by pressure. Elevation of the limb for a minute or less leads to rapid blanching of the foot on dependency the redness returns equally soon. The foot feels cold both to the patient and the examiner No pulsation is palpable at the posterior tibial or dorsalis pedis arteries, which the radiograph may show to be calcified The patient, lying on the couch, is asked to flex his toes repeatedly as quickly as he can This *soon brings on the pain in intermittent claudication.*

No treatment avails much Sympathectomy warms the foot but seldom stops the muscles claudicating

ŒDEMA OF THE FOOT

Postural Œdema Many women are apt to develop pain less œdema of the ankles and dorsum of the feet, especially in warm weather The cause is doubtless postural, since the patient wakes without the swelling, which comes on during the day

No treatment appears lastingly effective, hence elastic stockings should be prescribed. Varicose veins should be dealt with. Often reassurance as to the harmless nature of the swelling is all that is required.

Angioneurotic Œdema. This is usually very marked and unilateral As a rule no allergic cause is detectable and only *symptomatic treatment is possible.* Deep effleurage given daily followed by tight bandaging abolishes the œdema within a fortnight. The bandage is worn for another three months. If it is then abandoned, about half of all patients report that the swelling did not return. The others require an elastic stocking

DEFORMITIES OF THE FOOT

CONGENITAL DEFORMITIES

Equinus The triple deformity of talipes equino-varus (equinus at the ankle, varus at the talo-calcanean, adduction at the mid tarsal joint) is familiar to every medical man

But when one of these deformities occurs alone it may be overlooked at first. A pure equinus deformity results from short calf-muscles. An equinus deformity that disappears on pressure, only to reappear when this is released, may be the first sign to be noted of a cerebral diplegia.

Metatarsus Varus. This is an uncomplicated adduction deformity of the forefoot, sometimes accompanied by a hallux varus.

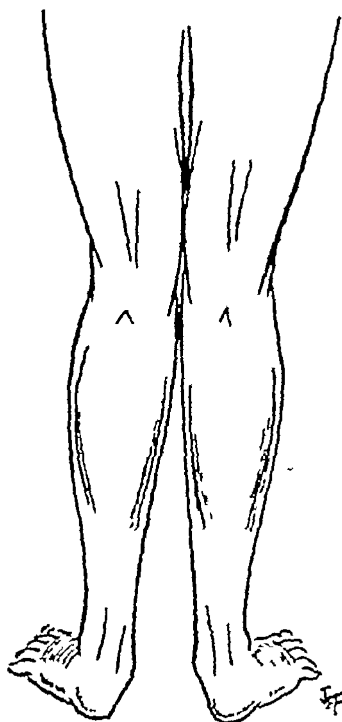


FIG 124 —Genu valgum deformity secondary to congenital inversion of the forefeet.

Metatarsus Inversus. This is an uncomplicated inversion deformity of the forefoot at the mid-tarsal joint, and is a common cause in children of valgus deformities at the knee and the heel (see Plate 85). In this condition, on walking, the outer side of the forefoot reaches the ground first. Then, as the patient's weight comes on to it, it rotates towards eversion until flat on the ground, thereby bringing the hindfoot with it and inducing a valgus deformity at the talo-calcanean joint—its worst posture. The hindfoot may also carry the leg with it and throw it slightly out of the vertical. Thus a genu valgum deformity develops in due course (see Fig. 124).

Talipes Calcaneus There is often a valgus deformity of the heel as well as limitation of plantiflexion range at the ankle. It has usually recovered spontaneously by the time the child has begun to stand if not, manipulation and strapping holding the heel in varus are called for

Pes Planus The congenital variety is rare. There may be calcaneo-navicular fusion Physiotherapy is naturally with out avail a steel support (see Fig 115) may help somewhat

Hammer Toe There is a fixed flexion deformity at the proximal interphalangeal joint with hyperextension at the distal joint. This would be symptomless but for the wearing of shoes, pressure against which causes a painful corn on the prominent joint.

ACQUIRED DEFORMITIES

Pes Cavus This deformity begins to be noticeable at the age of eight and progresses steadily until growth ceases at about the age of twenty, it then remains stationary The foot is short, broad and thick (see Fig 110), and the angle between the forefoot and hindfoot is abnormally small, sometimes even approaching a right-angle. The toes are clawed (*i.e* held in full extension at the metatarso-phalangeal joints and in flexion at the interphalangeal joints) because of the increased tone, leading to structural shortening, that develops in the extensor longus hallucis and digitorum muscles as a result of an attempt to compensate for the weakness of the interosseus and lumbrical muscles. A large callosity nearly always forms under the heads of the middle three metatarsal bones because—the toes not being used in walking—they transmit excessive pressure to the underlying skin.

Pes Plantaris By this is meant an over arched foot, *i.e* one in which the angle between the hindfoot and the forefoot is diminished (as in a cavus deformity) but the foot and toes are otherwise normal (see Fig 119) In women a minor degree of this condition is very common and not necessarily the result of wearing high heeled shoes. Adolescent girls, who have worn low heels all their lives, may nevertheless develop a plantaris deformity which results in painful strain until compensation is afforded by raising the heel of the shoe

In pes plantaris, the stress of weight-bearing first induces a greatly increased range at the mid-tarsal joint, particularly dorsiflexion-plantiflexion. To begin with no symptoms arise. Sooner or later the muscles of the sole of the foot prove unequal to the task of maintaining the plantaris position of the forefoot during weight-bearing. Excessive stress then falls upon (*a*) the capsule of the mid-tarsal joint (mid-tarsal strain); (*b*) the plantar fascia; (*c*) the metatarsal heads (metatarsalgia). Thus, three separate lesions may develop according to where in the foot the major strain falls.

This is the sort of foot that is often labelled "flat." It is not; it is over-arched, and flattens towards the normal shape only with pain.

Pes Planus. When excessive dorsiflexion takes place at the mid-tarsal joint, two further deformities arise: valgus at the heel and abduction at the forefoot. The calcaneo-navicular ligament, the capsule of the mid-tarsal joint, and the plantar fascia are all over-stretched; the first becoming painful, tender and prominent. Finally, shortening of the various joint-capsules may occur, thus fixing the foot in the deformed position. The deformity is now no longer reducible and cannot profitably be treated by conservative measures. Not all flat feet hurt; those that do not should be left alone.

Hallux Rigidus. This is the late result of an adolescent arthritis of the first metatarso-phalangeal joint (see p. 614).

Hallux Valgus. This deformity is symptomless unless complicated by arthritis, bursitis or pressure of the skin over the prominent bone against the shoe.

Treatment of Deformities of the Foot

In the treatment of any deformity here, two alternatives exist: either to force the movement that cannot be performed until good passive and active over-correction is obtained, or to compensate for the deformity by alterations to the shoe. Exercises, supports and strapping are used to prevent relapse. Both methods may be employed together.

For a Plantaris Deformity. Compensation is secured by raising the heel of the patient's shoe while keeping its upper surface horizontal (see Fig. 120). The short muscles in the sole must be strengthened in order that their tone may

retain the forefoot in the plantaris position during weight bearing and diminish movement at the mid tarsal joint. Furthermore their increased power takes pressure off the metatarso-phalangeal joint-capsules and the plantar fascia.

For a Planus Deformity The valgus element that occurs in this condition can be corrected by giving the heel of the patient's shoe a $\frac{1}{16}$-inch inner wedge, so as to push his heel over into a varus position as he takes weight. Since the abduction deformity is secondary to excessive dorsiflexion at the mid tarsal joint, plantiflexion should be encouraged here by providing the patient's shoe with an anterior wedge (see Fig 114) to the heel (as long as he has no equinus deformity) and by strengthening the short flexor muscles of the sole of the foot and the tibialis anterior and posterior muscles If these measures do not suffice, the fitting of a support, thick at the inner aspect of the mid tarsus, becomes necessary (see Fig 120)

When the deformity cannot be reduced voluntarily, the use of a Thomas's wrench under general anæsthesia may secure enough movement to enable the measures for a reducible deformity to be applied

For a Cavus Deformity *A child* may be seen whose foot has the typical shape but no symptoms have yet arisen. The progressive nature of the deformity should be explained and the importance of maintaining full length of the extensor longus hallucis and digitorum muscles, and full strength in the small muscles of the sole must be emphasized To this end, the child himself or an adult, should stretch the toes out daily, until full flexion is reached and maintained Resisted exercises towards toe-flexion follow The heel should be kept at a height adequate to compensate for the plantaris element in the deformity If this is done, and the child kept under observation, say once yearly, until the age of twenty, no symptoms need ever arise.

In adults with fixed deformity of the toes, division of the extensor longus tendons may be an essential preliminary to reducing the clawing This is very simply done under local anæsthesia. There is practically no after pain and the patient walks home immediately after the tenotomy He must keep stretching his toes out towards flexion for a few days to prevent the tendons uniting without lengthening

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height of a heel is raised without a change in the angle of its upper surface, plantiflexion occurs at the mid-tarsal joint. The same object is achieved when the heel is kept the same height but the angle of its upper surface altered to approach more nearly the horizontal. Good plantiflexion must be ensured here in order to maintain the reduction of a pes planus deformity. Again, the essence of the treatment of pes plantaris deformity is to allow increased plantiflexion during weight-bearing (see Fig. 121).

2. *To diminish Pressure on the Metatarsal Heads.* A thick platform stopping short of the metatarsal heads encourages weight-bearing by the whole extent of the metatarsal shafts and takes the weight off the metatarso-phalangeal joints (see Fig. 120). A metatarsal bar, which crosses the shoe just behind the heads, makes the necks of the metatarsal bones bear the greater weight; it is much less satisfactory.

3. *To diminish a Pes Planus Deformity.* The inner aspect of the mid-tarsus is kept raised by the provision of a support, thick under this area (see Fig. 118).

4. *To prevent Movement at the Mid-tarsal Joint.* When there is a mid-tarsal arthritis, pain is elicited towards the extreme of every movement. The application of a well-fitting steel to the sole of the foot prevents movement as far as possible.

5. *To compensate for Metatarsus Inversus.* This deformity may be discovered for the first time in middle age, perhaps because of a secondary posterior tibial teno-synovitis. The support must enable the heel to maintain the mid-position during weight-bearing; that is, it must allow the forefoot to remain inverted and yet in contact with the ground. To this end it is made like a wedge, thick at the inner and tapering to nothing at the outer border of the forefoot. It must project under the first metatarso-phalangeal joint almost as far forward as the interphalangeal joint. At the heel the support is level (see Fig. 125).

6. *For Sesamoiditis at the First Metatarso-phalangeal Joint.* A support taking the weight off the joint by providing thickness at the metatarsal neck seldom suffices. It should take the form of a ring, thick in front of, as well as behind, the sesamoid bone (see Fig. 117).

7. *For Calcanean Bursitis.* The support is $\frac{3}{8}$ inch thick

and is made of rubber A central depression ensures that the site of the bursa does not bear weight.

8 *For Strain of the Plantar Fascia.* As an alternative to raising the heel of the shoe a heel pad may be fitted. It may be of cork or hard rubber and ¼ inch to ½ inch thick, according to the patient's needs, and not wedged

9 *For Morton's Metatarsalgia* The alignment of the metatarsal heads is altered by raising the fourth on a small dome (see Fig 128) Occasionally the patient prefers the third and fifth bones raised, leaving the fourth relatively depressed (see Fig 127)



FIG 127 —Alternative support for Morton's metatarsalgia. Instead of raising the fourth metatarsal head (see Fig 128) the third and fifth are supported and the fourth allowed to sink down.

ALTERATIONS AND ADDITIONS TO THE SHOE

The following are commonly called for

1 *An Inner Wedge* When a reducible valgus deformity at the talo-calcanean joint is present, a varus position of the calcaneus during weight bearing can be secured by fitting an inner wedge to the heel of the shoe $\frac{3}{16}$ inch thick for adults, ⅛ inch for children (see Fig 128) An inner and an anterior wedge can often be advantageously combined.

2 *An Anterior Wedge* By this means a heel whose upper surface is oblique can be made horizontal and the shoe thus properly adapted to a foot with a plantaris deformity (see Fig 121) Shoes with a horizontal heel are most comfortable to nearly all women, it is therefore the more surprising that women's shoes are always made with an oblique heel—which looks no more elegant and in fact increases the apparent length and diameter of the foot—and hence are so shaped that the waist of the shoe is not in contact with the sole of the foot. All women with a tendency to plantaris deformity of the forefoot ought to wear horizontal heels these have several important advantages (*a*) the patient can

CHAPTER XXIII

ANÆSTHESIA AND ANALGESIA

LOCAL anæsthesia has many important applications in orthopædic medicine. General anæsthesia has its indications, but tends to be used too often. Heat applied to the tissue at fault is the physiotherapist's analgesic agent for minimizing the pain for many uncomfortable treatments. But the universal employment of heat for all sorts of painful disorders is ridiculous.

Local anæsthetic agents are themselves weakly basic but are used clinically as their acid salts, with a pH of 4 to 6. Most are derivatives of benzoic or amino-benzoic acid. Since the tissues are slightly alkaline, the free base is probably liberated within a few seconds. They are dissolved in normal saline, otherwise weak solutions (under 1 per cent) are hypotonic enough to cause hæmolysis of red cells and rupture of connective tissue. For fear of decomposition the solution should be preserved in alkali-free glass ampoules. Since the solution may need to be introduced into a joint or into the epidural space—both areas where absolute sterility is essential —rubber-capped bottles that are used several times are unsuited to the practice of orthopædic medicine. A stock of 50-c.c and 10-c.c. ampoules caters for every need. On account of their acidity, strong concentrations may cause considerable after-pain; since they afford no better anæsthesia, there is no point in exceeding a strength of 1 : 200. The solution should not contain added adrenaline, since vasoconstriction hinders the very diffusion of the solution that is desired Procaine, ethocaine and novocain are different trade names for the same substance.

After-pain comes on between one and two hours of the injection. If, as is recommended, a 0.5 per cent solution is employed, the reaction is slight except after injections into the tendons at the shoulder, when quite severe discomfort may continue for up to two days. It is impossible to make a patient lastingly worse by inducing local anæsthesia, unless he is allowed to exert himself harmfully during his period of

painlessness. Hypersensitivity to local anæsthetic agents is very rare those patients who allege that on previous occasions they have been unable to tolerate it will nearly all be found to have reacted not to the anæsthetic agent but to the vasoconstrictor drug injected with it. This fact is easily demonstrated by a small test dose injected without adrenaline. I have met with only one case Twenty minutes after an uneventful induction of epidural local anæsthesia, the patient felt very dizzy while walking round the room. Within a few minutes he became unconscious and respiration ceased Artificial respiration had to be continued for two hours, when he came to, none the worse for the reaction Resistance to local anæsthesia is an extreme rarity

A 10-c.c. syringe is the most useful size and is adequate for most infiltrations. To this is fitted a long thin needle, mine is two inches long and 28 B W G in diameter When, say, the back of the capsule of the hip-joint requires infiltration, a needle three inches long and 20 B W G is the smallest serviceable size. For epidural work, a 50 c c syringe is required together with a lumbar puncture needle and stylet.

Only the skin puncture hurts appreciably thus, if thin needles are used, previous local anæsthesia with a fine needle at the point to be pricked is unnecessary As the injection proceeds, the needle is withdrawn to almost its full length and then reinserted a little farther along by altering the angle of the syringe. In this way, with a long needle, and only one skin puncture, quite a large area can, if necessary be reached. When larger bore needles are employed for aspiration of a joint or epidural injection, local anæsthesia of the skin should be induced first by 1 c.c. of 2 per cent procaine solution with adrenaline.

DIAGNOSTIC LOCAL ANÆSTHESIA

Local anæsthesia is the great standby of the orthopædic physician when faced—as he is bound to be every day—with a difficult diagnosis. It provides him with his only method of keeping his feet on the ground It is easy to assume that a certain set of signs designates a certain lesion local anæsthesia alone provides confirmation or disproof The lesions

dealt with in orthopædic medicine do not cause death; this is why they have remained so nebulous for so many centuries. The orthopædic physician is denied the discipline of the post-mortem room, where his colleagues never cease to learn. This disadvantage can be offset by *free use of diagnostic local anæsthesia*, whereby the conscientious physician confirms or disproves all his tentative localizations repeatedly until he knows that his diagnostic opinions rest on a firm basis. I kept this up for ten years, and still employ local anæsthesia in all difficult cases.

Diagnostic local anæsthesia entails the injection of the solution into the tissue from which a pain is thought to originate in order to determine whether or not the removal of percipience at this point relieves the symptoms for the duration of local anæsthesia—about an hour and a half. As little as possible should be injected, so that the physician can be reasonably sure that only one point has been numbed. Except for epidural work, 5 or 10 c.c. of solution are ample. It is by no means enough, a few minutes after the infiltration, to ask the patient if his pain has ceased; whatever movement was found the most painful before must be tested again.

The information gained in this way is good evidence at the limbs, where an incorrectly placed solution will not abolish a pain referred to the numbed region. By contrast, at the trunk false positives are not infrequent and many, myself included, have temporarily abolished pain in reality due to disc-lesion by local anæsthesia induced at the muscle where the pain and tenderness were felt. At first this finding naturally deceived me as much as it did others, and led me to imagine that there really was such a disorder as fibrositis. But study of the responses to diagnostic movements showed signs inconsistent with a muscle lesion, and led to the realization that *at the trunk* local anæsthesia induced at the wrong place does sometimes abolish pain. This is a remarkable phenomenon, so far unexplained.

THERAPEUTIC LOCAL ANÆSTHESIA

Local anæsthesia has a large number of therapeutic applications. However, a widespread tendency exists at present

to use local anæsthesia rather at random, without the full preliminary examination that alone affords an indication of where the lesion is situated. While an occasional success can be achieved by injecting a tender spot close to the site of a patient's pain only discredit will be brought upon the use of local anæsthesia by such indiscriminate use Full use must be made of the diagnostic criteria set out in Chapter VI, and the injection given, not at some site of tenderness, but at the point where the lesion has been shown to lie Alternatively, the needle may be aimed at a definite structure *e.g* the stellate ganglion

INDICATIONS FOR THERAPEUTIC ANÆSTHESIA

1 *Recent Injury to Soft Tissues*

If the damaged structure is rendered anæsthetic within a few hours of injury, the usual sequels are much diminished or almost completely obviated. This is best seen when the treatment is applied to a sprained knee or ankle the swelling ceases to increase, muscular spasm is relaxed, use of the injured limb is facilitated and the ensuing disability is likely to last as many days as it might otherwise have lasted weeks Since œdema, effusion into the joint and protective muscular spasm are presumably reflex phenomena, Leriche's hypothesis that afferent impulses from the injured structure are abolished appears reasonable. A possible alternative explanation is that a pain producing substance is inactivated or dissolved in the injected saline solution and progressively removed as this solution is absorbed from the tissues.

My practice is to infiltrate all ligamentous sprains seen within the first twenty four hours, and at the same time to aspirate any effusion, whether serous or hæmorrhagic, that is large enough to set up uncomfortable distension Treatment by massage and movement is begun the day after the initial induction, further infiltrations are not well tolerated nor of therapeutic effect comparable with injection followed by the measures for rehabilitation described throughout this book

The time limit of twenty four hours is purely empirical, but, since local anæsthesia may be expected to prevent altera

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The time-limit of twenty four hours is purely empirical, but, since local anæsthesia may be expected to prevent altera

tions from occurring but not to affect structural changes already in existence, I doubt if this period can usefully be extended in the case of ligamentous injuries. On the other hand, no such time-limit applies to the treatment of minor muscular ruptures. These respond the better the sooner after the injury the infiltration is performed, but lasting improvement may follow local anæsthesia induced weeks, even months or years, later. Teno-synovitis and tendinitis are never improved by infiltration at any stage; indeed, considerable after-pain is to be expected.

2. *Intramuscular Scarring*

There are certain muscles at which long-standing pain is usually lastingly relieved by one or two infiltrations with a local anæsthetic solution. It will be noticed that it is lesions at a distance from the attachment of muscle to bone that respond in this way (see Fig. 1). The reason would seem to be that the muscle is easily distensible by fluid only at the centre of the belly. The introduction of fluid ruptures inter-fibrillary adhesions by hydraulic pressure: an action weaker than, but strictly analogous to, that of deep transverse massage. The result is similar because the solution pushes the fibres apart from within, whereas deep friction pulls them apart from without.

The muscles are: pectoralis major, latissimus dorsi, extensor carpi bellies in the forearm, psoas, quadriceps, gastrocnemius and interosseous pedis muscles.

Adhesions about a ligament may be ruptured by mobilization under local as under general anæsthesia; this has nothing to do with the therapeutic effect of local anæsthesia

3. *Fractures*

Except in fractures in which anæsthesia of the bone-ends might lead to movements tending to increase deformity, one or several injections directed between the fractured surfaces are indicated during the first five days after the injury. Since, moreover, procaine hydrochloride is an acid, and the first step in the normal repair of a fracture is the appearance of an acid solution about the bone-ends, there appears to be some

theoretical justification for Leriche's claim that callus formation is hastened Certainly stiffness at neighbouring joints is largely obviated The method is particularly suitable in fractures of the surgical neck of the humerus (in which the chief concern is to avoid a stiff shoulder) and in those of the fibula and clavicle (in which relief of pain is the more important consideration) The symptoms in uncomplicated costal fractures arise from the intercostal muscles rather than the break itself hence this condition should be regarded more as recent trauma to muscles than as a fracture, and therefore as requiring infiltration of the muscles rather than between the broken ends of the bone

Local anæsthesia is also very suited to the reduction of fractures of some of the smaller bones indeed, I regard it as the method of choice for a Colles's fracture It carries the great advantage that the manipulation and the subsequent application of the plaster cast can be undertaken unhurriedly Moreover there are times and places at which the attendance of another practitioner as anæsthetist is difficult to secure.

4 *Painful Superficial Scars*

The two effective non-surgical treatments are 1 Local anæsthesia. The whole scar should be raised up by introducing the solution between skin and subcutaneous fascia. One infiltration is usually enough. 2 Hydrocortisone. This has proved successful when local anæsthesia has failed

5 *Bruised Nerve*

After a nerve has been subjected to local pressure or friction it remains sensitive for months. Lasting diminution in such sensitiveness often follows the induction of local anæsthesia at the sheath of the affected extent of nerve-trunk. The median nerve at the wrist affords a good example.

6 *Bruised Dura Mater*

The same considerations apply in backache, after slight pressure has been applied for many months to the dura mater as the result of a minor central posterior herniation of disc substance. Sometimes permanent or semi permanent loss of

4. *Repetition.* It is regarded as unwise, when maximum doses are being used, to induce local anæsthesia twice in twenty-four hours.

Toxic Reactions

In the dosage used by the orthopædic physician, toxic effects are very rare. If they occur, the patient's head is lowered and, if necessary, artificial respiration is begun. Convulsions are best treated by a short-acting barbiturate, *e.g.* pentothal. Collapse and tachycardia due to idiosyncrasy to procaine has been found by Buff (1950) to be relieved by a subcutaneous injection of 0·5 to 1 mgr. of neostigmine methylsulphate.

The slight dizziness and headache that some patients experience for up to fifteen minutes after an epidural injection are the effect, in my view, of a temporary increase in the cerebrospinal fluid pressure, owing to the introduction of fluid into a closed space. It appears unconnected with any toxic effect, for the maximum dose is 0·5 g. and 50 c.c. of a 0·5 per cent solution represents only half this amount.

STELLATE BLOCK

Blocking the stellate ganglion by local anæsthesia is quite a simple procedure. In 1937 Leriche showed me his technique for reaching the ganglion, but de Sèze's modification (1946) is even simpler.

TECHNIQUE

This description closely follows de Sèze's recommendations (see Fig. 130).

1. The patient lies with his head turned away from the side to be injected.

2. A line is drawn from the tragus to the sterno-clavicular joint. The point where the needle is inserted lies half an inch lateral to this line, and one inch above the inner end of the clavicle.

3. The operator presses hard backwards with a finger to each side of the selected point. This pushes the carotid-jugular bundle out of the way.

4. A thin needle two inches long is inserted and thrust

almost straight backwards at about one and a half inches it hits bone. The needle passes above the apex of the lung and lies medial to the brachial plexus

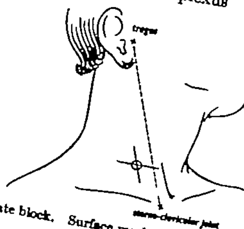


FIG. 180.—Stellate block. Surface marking for insertion of the needle

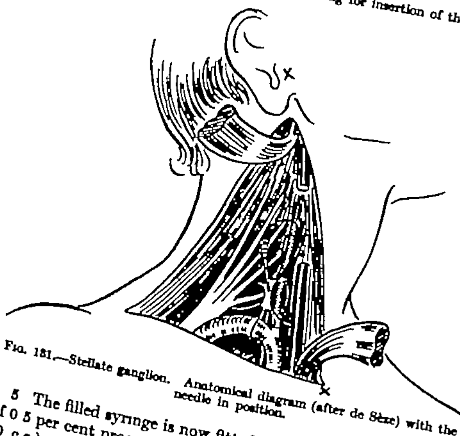


FIG. 181.—Stellate ganglion. Anatomical diagram (after de Sèze) with the needle in position.

5 The filled syringe is now fitted to the needle and 10 c c. of 0 5 per cent procaine are introduced (de Sèze recommends 20 c.c.) No pressure is required for the injection if the operator finds he has to press hard the needle has gone too

far backwards and its point lies between the transverse processes of the seventh cervical and first thoracic vertebræ.

6. The patient remains supine for a few minutes.

The injection causes a minimum of immediate discomfort and only slight stiffness of the neck when the tissues come to later on. If the needle pierces the vertebral artery it is withdrawn and digital pressure applied for two minutes; the needle is then reinserted pointing slightly more medially.

TEST OF A SUCCESSFUL BLOCK

Horner's syndrome develops within a few minutes. The pupil contracts and the conjunctiva pinkens; ptosis develops, and that side of the face flushes. The hand feels warm and the veins on its dorsum swell.

INDICATIONS

So far as orthopædic medicine goes, the main indication for a stellate block is freezing arthritis at the shoulder in the first stage (see p. 214).

Other conditions that respond are: post-traumatic osteoporosis (Sudeck), causalgia, a painful phantom limb, thrombosis of the axillary artery, hemiplegia. Benefit has been reported in Ménière's and Raynaud's syndromes, angina, spasm of the retinal artery and migraine. When used for reversing the progress of a freezing arthritis, the indication for the next block is the reappearance of the pain in the arm at night; this usually entails three or four injections ten to fourteen days apart. In each recent hemiplegia, on the other hand, an injection twice a day is required at first.

INTRAVENOUS PROCAINE

General relaxation, analgesia and semiconsciousness result from procaine introduced by intravenous drip at the rate of 20 mg. a minute (approximately a gram an hour).

In orthopædic medicine it has its chief use in the treatment of low lumbar disc-lesions (see p. 409), especially those at the

fourth lumbar level with marked lateral deformity The patient's muscles relax completely and are kept so for several hours by a continued drip This enables spontaneous reduction to take place.

After an operation, especially on the upper abdomen, such great restriction of respiratory movements results that ventilation in the lungs may be diminished by two-thirds If pain is abolished deep breathing returns hence many post-operative respiratory complications are avoidable by intravenous procaine Asthma has been shown to benefit.

PROCAINE ORALLY

When the stomach is in the resting state, the pylorus is patulous. The sphincter closes as soon as the food reaches the stomach, opening later from time to time to let a small amount into the duodenum. If 100 c.c. of 0 5 per cent (adult dose) procaine solution are drunk before a meal, the lining membrane of the stomach loses its sensibility hence the pylorus does not close. This treatment may be required in pyloric spasm and might well be tried in the pyloric stenosis of babies.

GENERAL ANÆSTHESIA

If pain and muscle spasm combine to make it impossible for a patient to allow a desired movement to be forced, general anæsthesia is called for Manipulation of the knee and shoulder provide the common indication for general anæsthesia in orthopædic medicine If the anæsthetist gives pentothal quickly in a small amount, several minutes' complete relaxation is obtained and proves as satisfactory to the operator as the induction and re-awakening are pleasant to the patient. Though nitrous oxide is less pleasant to the patient, it is the anæsthetic agent of choice when Mills's manipulation for a tennis-elbow is carried out for in this case muscular relaxation must be avoided Most patients are able to go home alone half an hour after nitrous oxide anæsthesia. Pentothal, however leaves the patient euphoric

for some hours. He can go home after one or two hours, but a friend must go with him and he is not fit to drive a car.

CONTRA-INDICATION

If a set manipulation is to be carried out, *i.e.* the manipulator knows in advance exactly what he will do, general anæsthesia is a help. If the manipulation is not set, anæsthesia is a hindrance. Hence spinal manipulations cannot be performed properly under general anæsthesia, with the exception of the straightforward mobilization of the cervical joints for osteo-arthritis. When fragments of disc are being reduced at any spinal level, the patient's co-operation is essential. One manipulation is carried out; the result is then assessed. Depending on the result, the same manipulation may be repeated. Unless the patient is conscious and made a party to the progress of the manipulation, the orthopædic physician does not know whether to stop or to go on and in any case what to do next. The creation of added difficulties for the manipulator by the use of general anæsthesia for the spinal joints springs from a confusion of thought. If a standard technique suffices, as it does for the joints of the limbs, anæsthesia makes the operator's task easier and saves his patient pain But the spinal joint is not being mobilized (*i.e.* merely put through its full range of movement). Reduction is being attempted. Is reduction complete or not? Did this or that manipulation alter the position of the loose fragment; if so, for better or for worse? None of these questions can be answered without the conscious patient's active assistance.

It is argued that better relaxation is attained by the use of anæsthesia. Clearly, this is so; but in my experience conscious patients relax quite enough for reduction to be achieved. The slight advantage that general anæsthesia might afford is heavily outweighed by the disadvantage of the patient's unconsciousness.

PARTIAL LOCAL ANALGESIA

Local analgesia results when the circulation through the painful area increases. If the lesion is flushed with blood,

oxygenation of P factor is hastened so much that pain eases or, if a subliminal level is reached, is wholly abolished for the time being Such analgesia should be brought about for some definite purpose, and treatment, whatever it is, must be given at once afterwards while the local circulation remains enhanced. Heat, deep massage, short and ultra sonic waves are three partial analgesic agents, counter irritation is based on error and is out of date

1 HEAT

Heat is a suitable analgesic agent when a painful treatment has to be repeated often and at short intervals Heat is the physiotherapist's standby for this purpose, but it is useless to heat an area and then merely let it get cold again. The heat is the prelude to some treatment affecting the lesion not an end in itself Only in septic conditions is an increase in circulation of itself beneficial, bringing more leucocytes to the part

Abuse of Heat

The lesion must be heated, not the overlying skin Hence if heat is to be used at all—and it is not often required—short wave diathermy alone avails in deep-seated lesions, a wax bath is suitable for hands and feet. But during short wave diathermy the lesion is merely heated, and when the rays are removed the lesion cools off again. Except in sepsis, where the increased circulation can be beneficial, warming a lesion and then letting it get cold again is an absolute waste of time Radiant heat and infra red rays are not required in orthopædic medicine

It is a remarkable fact that numberless heat lamps are in use all day and every day at all hospitals in this country yet they emit rays that do not penetrate far enough and are thus entirely unable to affect the lesion present. Not only are such rays useless, but their employment prevents the patient, though he may not realize it, from receiving real treatment, to that extent superficial irradiation is harmful. It is thus not only a waste of the hospital's time but even a real abuse of patients confidence to fob them off with rays that cannot

help them. The rays that emanate from a medical radiant-heat lamp originate from a red-hot wire; so do those of an ordinary domestic electric fire. Infra-red rays are not very different from those given out by a hot-water bottle. If then, a patient should really require treatment by either of these types of heat, it is clearly undesirable—to say the least—that he should spend time and money travelling to and from a hospital for a treatment that he can secure in his own home more conveniently, more cheaply, more often, for longer periods at a time, and without wasting a busy department's space. The abolition of such vague and transient palliation would serve to focus attention on methods of treatment that do lasting good, though they are admittedly all less pleasant at the time of administration. Physiotherapy would thus fall in line with the rest of medicine, something, even if unpleasant, being done for the sake of future relief, rather than the prescription of an ephemeral placebo.

Heat is contra-indicated before deep massage is to be given. If the overlying skin sweats, the physiotherapist's finger slips during the friction and she cannot avoid raising a blister. There is little to be said for, but nothing against, heat of any sort given afterwards, so long as the period of massage is not cut short for this purpose.

2. DEEP MASSAGE

Numbness, not amounting to full anæsthesia, follows vigorous deep friction. I call this phenomenon "massage analgesia." Nothing is more surprising or apparently illogical than that massage given vigorously to the tender spot in a soft structure should make it less painful to use while increasing its tenderness. This fact, which any sceptic can quickly prove for himself, is an important result of the use of deep friction. The hyperæmia that results from the trauma inherent in deep massage increases the speed of destruction of Lewis's P-substance; deep heating does the same. But the affected structure lies passive during the administration of heat, whereas during deep massage it is moved to and fro by the physiotherapist's finger. Hence, while heat enhances the blood-supply and thus induces a brief period of analgesia and nothing more, deep massage both increases the blood-

supply and moves the painful tissue. This aids subsequent gentle or forced movements (according to circumstance), which follow at once, i.e during the period of massage analgesia. In the proper case, massage analgesia is most successful in enabling the patient to tolerate the performance of movements that would otherwise have proved quite unbearable.

3 ULTRA SONIC WAVES

These produce thermal, mechanical and chemical effects on living tissues Heating is greatest at the opposing faces of tissue layers, e.g fascial planes, the surfaces of joint capsule or periosteum. The rate of diffusion is enhanced with consequent increase in local metabolism and hyperæmia Oxidative processes are accelerated. It seems possible that deposits of fibrous tissue might be mechanically softened these waves were therefore tried on a series of cases of tennis elbow—with gradual benefit in only some cases. Supraspinatus tendinitis was aggravated. Varicose ulcers, spondylitis deformans and Dupuytren's contracture, on the other hand, have responded very slowly but reasonably well.

4 COUNTER IRRITATION

Various irritant substances and ultra violet light have been used in the past. Since short wave diathermy can apply heat at any depth from the surface, the very indirect method of attempting to increase the circulation by stimulating the skin over a lesion is falling into disuse. This is welcome, for recent research suggests that when much blood is drawn to the skin, the deeper tissues may become less well supplied and the reverse effect of that intended ensues Nevertheless, even now, it is not uncommon to see patients with circles of sunburn produced on the skin over the site of a pain but it is difficult to understand what purpose they may be expected to serve. If the methods set out in this book are followed the production of cutaneous hyperæmia and pigmentation at the site of a symptom are supplanted by measures that directly affect deep-seated lesions.

Ultra violet light is valuable treatment for some super

ficial lesions, *e.g.* ulcers, whether septic or varicose, erysipelas and herpes zoster. However, varicose ulcers respond better to massage (see Vol. II), erysipelas to antibiotics and herpes zoster to local anæsthetic creams; hence ultra-violet rays are being displaced by more effective methods. Lupus vulgaris requires special lamps; moreover, the ingestion of calciferol has largely replaced irradiation.

General ultra-violet baths stimulate metabolism and may thus act as a general tonic. They also result in the production of vitamin D by the patient's skin, and so might be used in the treatment of deficiency of this vitamin, chiefly rickets. But it is far cheaper and simpler to give the patient vitamin D by the mouth. They are widely regarded, quite mistakenly, as a preventative for colds and influenza (Colebrook, 1946).

CHAPTER XXIV

PSYCHOGENIC PAIN

PATIENTS with pain devoid of organic basis naturally gravitate to the orthopædic physician since it is he who normally deals with patients whose symptoms give rise to little or nothing by way of physical signs Since examination on standard lines for pains in the trunk and limbs is not widely practised, many doctors possess few criteria on which to base a reasoned opinion. If the patient is subjected to the type of examination outlined in this book, it is difficult for imagined disorders to escape detection at his first attendance. On the whole patients with genuine pain whose reality is doubted are less numerous than those who have partly or wholly carried off the deception

Doctors, particularly those on whom physiotherapists depend for guidance, must learn to sort out cases of psychogenic disorder, as much for their own sake as for that of their staff They cannot form any true estimate of the results of treatment if they are frequently misled by dramatic cures in such cases following manipulation, an injection, faradism and so forth It is extremely human to regard a diagnosis as correct if treatment based on it results in immediate cure nevertheless, the practitioner must steel himself against an over facile acceptance of such results. After all, this type of reasoning provides an apparent foundation for much unscientific healing

The fact that patients with every sort of obscure pain are sent to an orthopædic physician for diagnosis and treatment is to be welcomed as providing him with a series of interesting problems. While it is no substitute for a diagnosis to regard every patient with a symptom whose source is not immediately apparent as suffering from an imaginary disorder, much confusion of mind results from a disposition to believe too much The doctor must retain a mind open enough to accept and register as they crop up disorders with which he was previously unfamiliar He must therefore be careful to maintain the difficult balance between excessive scepticism and credulity

account from a patient apt to ramble or unable to explain himself well. By contrast, patients with psychogenic pain are very apt to embroider, and their symptoms may be heard to come and go in the most improbable ways or to diffuse further and further as the tale continues. Radiation may be alleged, grossly transgressing the rules that referred pain keeps within one dermatome and does not cross the mid-line. Thus unilateral pain may spread to both limbs, or a pectoral pain travel down to the lower abdomen. Since it is at all times more difficult to be sure that a patient has not got a pain than that he has, the ability to listen without losing patience and to assume a sympathetic manner often repays the examiner well. Moreover, the patient who is thus encouraged to go on talking, as well as contradicting his own earlier statements, may advance irrelevances that afford a clue to the true origin of his symptoms

INSPECTION

Little is to be expected from inspection, for should this reveal obvious abnormality, the question of purely psychogenic symptoms hardly arises Difficulties are encountered when a patient knows that he has a deformity, perhaps postural since adolescence or the result of past disease or fracture, and makes use of it to give colour to his story.

Inspection of the gait may reveal a limp or small shuffling steps or a joint held stiffly for which no limitation of joint movement, loss of muscle power or impairment of nervous control can later be found to account. Joints assume a characteristic posture when diseased, whereas psychogenic stiffness characteristically results in fixation in quite different positions, *e g.* medial rotation at the hip, full extension at the knee, varus at the heel

EXAMINATION OF MOVEMENTS

As has already been set out in Chapter VI, the responses on examination of patients with organic lesions form a pattern If a pattern new to the examiner results, he must consider whether it is an impossible or a conceivable one. For example, a complaint of pain on all the resisted movements at the scapula, shoulder, elbow and wrist joints is

incredible, since it would identify the lesion as situated in a dozen different places On the other hand, the fact that every resisted shoulder or hip movement hurts is consistent with acute internal derangement of a cervical or lumbar inter vertebral joint, but, in such a case, direct examination of the neck or lumbar movements must reveal a severe disorder If therefore little abnormality is detected here, great doubt is thrown on the reality of the symptom Except at a few sites, and then in a known manner, limitation of movement at a joint is accompanied by proportionate limitation in the other directions as well. Pain on a resisted movement is accompanied except in rare instances by a full range of movement at a joint, and the extremes of such movements as neither stretch nor squeeze the affected muscles are always of full range and painless Weakness of some resisted move ment may be alleged when the visible bulk of the relevant muscle shows that it is strong Alternatively the mere fact that the patient walked in may show that such weakness is unreal

Trial of a series of active, passive and resisted movements at a number of joints accompanied by a request to be told whether each hurts or not is a very confusing examination to a patient without organic disease He cannot know nor work out quickly in his mind, which movement he should state to be painful and which not. He is therefore apt to guess wildly his random answers constituting a pattern in consistent with any lesion. Or he may say that every movement sets up pain, this is too much for both the resisted and the passive movements at a joint cannot set up pain Suspicion is aroused by readiness on the part of the patient to allow the examiner's tone of voice to influence his response to movements, or by a pause followed by a glance at his face that appears designed to read his countenance. More difficulty is presented when every movement is stated to leave the pain unaltered, for this is a perfectly possible finding in visceral pain (since the wrong parts are being examined) or in some cases of pressure on a nerve-trunk.

Patients naturally suppose that the first act of the examiner after he has listened to their story is to request them to make a movement that sets up pain. A part of the body as far distant as is reasonably possible from the allegedly affected

is perfectly consistent with an organic lesion situated elsewhere and referring pain to this spot.

RADIOGRAPHY

Although it is a sad waste of material, this examination should not be omitted. An unexpected positive finding is a great rarity, for soft tissue lesions that have progressed to the point of altering the radiological appearances are usually advanced enough to make the clinical diagnosis easy. Care should be taken that the presence of some trivial abnormality, *e.g.* an osteophyte or a diminished intervertebral joint space, is not regarded as proving a patient's symptoms to have an organic cause.

FINDINGS IN SUSPECTED PSYCHOGENIC PAIN

The possible findings on examination conducted on these lines fall into four main groups.

1. ABSENCE OF ORGANIC LESION

In the most obvious cases the history is remarkable; the disability is out of proportion even to the alleged symptoms; the responses to diagnostic movements conflict, clear inconsistencies are detected; tenderness is diffuse. If the patient appears to have a conscious belief in the reality of his symptoms he is regarded as suffering from a psychogenic disorder. If he does not even believe in them himself, his pain is assumed and he is termed a malingerer. The examination reveals only the absence of organic basis for the patient's pain; the study of his state of mind during this time may or may not allow of an opinion on how far he believes in his own symptoms. No hard and fast line can in any case be drawn; cases at each extreme are clearly enough defined but they merge at a centre about which self-deception changes to conscious assumption.

2. ORGANIC LESION WITH PSYCHOGENIC OVERLAY

These are difficult cases requiring much patience and clinical experience to disentangle. The symptoms and

physical signs, though largely correct in quality, are grossly excessive in quantity Moreover mixed in with and obscuring the genuine factors are unbelievable complaints and alleged signs. A good deal of time and considerable repetition of the examination may be required to enable the real lesion to emerge after it has been sorted out from the welter of unfounded symptoms. In such cases it is often wise to have the patient brought to a more reasonable frame of mind by a fortnight's indifferent treatment from a physiotherapist. She, by her unemotional and common-sense view, can nearly always get a patient so to collect himself that, at the next examination, it is hard to believe that there could have been any difficulty in arriving at a diagnosis.

Though the patient has brought the misdiagnosis on himself, unfairness results if such patients are regarded as suffering from a purely psychogenic disability Treatment by suggestion is very apt to be found powerless in the presence of real—however minor—pain by contrast, the relief of the genuine lesion, by depriving the patient of the basis for his malady, is often curative alone. Even if it is not, he is now rendered accessible to psychotherapy

3 PAIN IN NEUROTIC PATIENTS

Another difficulty is the psychoneurotic patient who happens to develop a painful condition His excessive distress and nervous behaviour on giving his history conflicts with the simple and consistent pattern that, to his own and the physician's surprise, is discovered on examination The hypersensitive state present must be allowed for when treatment is ordered, but there is seldom any need for treatment to his mental state which, as long as no painful disorder has upset his balance he has coped with quite well for years.

4 NO PHYSICAL SIGNS DETECTED

There always remains a very small group of patients in whom no decision can be reached The history is quite credible and the response to movements unhelpful but constant on repetition and devoid of inconsistency Tenderness may be absent and local anæsthesia unavailing Sometimes

repeated examinations may enable a decision to be reached in the end; in a very few cases the examiner is never really able to make up his mind.

Elderly patients with, for example, a minor disc-lesion at an osteophytic spinal joint may present no clear signs to explain their brachial, thoracic or sciatic pain. In due course such signs do develop sometimes; only analogy with these cases enables a diagnosis to be made early on. In other cases, also of *irritation of the sheath of a sciatic* nerve-root, the pain may be felt at, say, the calf only and, even if this possibility is kept in mind, investigation may at first reveal nothing. Paræsthesiæ in one hand may be the first symptoms of protrusion of a cervical intervertebral disc, or of the thoracic outlet syndrome, or of compression in the carpal tunnel; at first all signs may be absent. Pain in the groin, iliac fossa or testicle may result from dural irritation at a low lumbar level, no signs of which may appear for a long time

In such cases the fault clearly lies with the examiner rather than with the patient It is my practice, after repeated endeavour has failed to detect the lesion, local anæsthesia has drawn a blank, and a short course of such treatment as suggested itself has failed, too, to confess to the patient that I have been unable to arrive at a diagnosis. In fairness I add that I do not doubt the genuineness of the symptom, that since clinical examinations and radiography have all failed to disclose its source it is most unlikely to be anything serious; that he is welcome to come and be seen again at any time; that further treatment is clearly waste of time equally for the patient as for the department; that, should a diagnosis ever be arrived at, or any method of treatment prove effective, he must be sure and let me know for my own and future patients' sake.

TREATMENT OF PSYCHOGENIC DISABILITY

In my view, it is unreasonable to refer all patients with minor psychogenic trouble to the psychologist In the first place, that department would become swamped in a few weeks. Moreover, simple suggestion of the type that physiotherapy supplies often succeeds in dispelling symptoms, at

which the patient practises the hitherto impossible or painful movement. On the other, she too maintains a pleasant and encouraging manner the whole time. Her conversation should turn on the patient's life and circumstances, and emphasize the advantages to him of getting well The patient, swayed in the same direction by such pleasant people and such disagreeable measures, more often than not declares himself well after a week or two of such treatment. As a matter of statistical fact, seventy-six of the one hundred and seven patients seen in 1943 and regarded by me as suffering from purely psychogenic symptoms declared themselves well and returned to work at the end of two or three weeks Compensation cases are not included in this series

Treatment should not be continued for longer than two or three weeks A fortnight's stimulating physiotherapy may induce a patient to state that he is cured, if not, prolongation of treatment is merely added evidence to him of the presence of organic disease. Hence, in the remaining patients, the decision has to be taken whether they should merely be discharged and a letter written to their doctor explaining the position or they should be referred for psychological treatment. Consideration of the patient's age, work, responsibilities, apparent character and value in the social world determine the result; obviously the almoner's investigations bear strongly on these points This residue of patients, otherwise reasonably sound human beings, for whose relief these superficial measures have not sufficed, are troubled by deep unconscious motives that the psychologist alone can deal with, and they provide him with worthwhile material.

It may well be argued that this is a most superficial approach to a deep-seated psychological frailty and that nothing has been done to prevent recurrence of symptoms later or to build up the patient's strength of will. This is true; but even the best psychologist cannot evoke character of which the patient is constitutionally devoid. Moreover, that a psychologist should spend many hours in the attempt to build with such inferior material is, at least in hospital practice, a great deal to ask. Hence, the rough and ready method outlined here, since it so often results in the patient's speedy resumption of his proper activities, may be regarded as a reasonable pragmatic approach, however unsound in its

theoretical aspect. Indeed, no patients are louder in their praises and thanks than those who have been relieved of psychogenic symptoms. Only a few, less than 10 per cent, return with further allegations during the next two years—at any rate to the same hospital!

THE LADY ALMONER'S PART

It would be absurd to send all patients with psychogenic symptoms without further ado to the psychologist. He would find his department cluttered with trivial cases reaching him far more rapidly than the rate at which he could possibly cope with them. Moreover, many patients of this type are endowed with such weak characters that his skill and time are inadequately rewarded even when ephemeral alleviation results In my opinion it is amply justifiable in the first place to turn such patients over to the combined efforts of the lady almoner and physiotherapist.

The work of a conscientious and understanding lady almoner supplies a vital part in the treatment of psychogenic pain, for she represents the patient's link with the outside world She must possess aptitude and human understanding, and be afforded enough time to give special attention to those cases in which a doubtful or unqualified diagnosis has been reached of pain devoid of organic basis or complicated by a neurotic overlay Almoners have told me that they have found some of the most interesting problems arising from their work to lie in dealing with this type of case. During her enquiries into domestic, workaday and financial circumstances factors may come to light that serve to explain the alleged disability I have even known patients, after putting up quite a convincing display when seeing me, tell the lady almoner straight out that their symptoms are assumed and explain their purpose. In doubtful cases, the discovery by the lady almoner of the presence or absence of conscious or unconscious motives serves to lend weight to, or detract from, the doctor's tentative diagnosis. Her conversation also enables her to help in dividing patients into the relatively deserving and undeserving Some patients seek relief from unpleasant situations only on severe provocation, in such cases the lady almoner can get in touch with employer or

Labour Exchange, visit the home or arrange for various forms of assistance or convalescence Others allege symptoms for the most unworthy reasons, in these cases it would be an abuse to bring such facilities to the patient's aid. The almoner can also help to pick out those cases in which the nature of the domestic background indicates that a short talk by the doctor with a member of the patient's family is desirable.

TRAUMATIC NEURASTHENIA

Anxiety neurosis resulting from an accident and leading to disordered function goes under the above name. Such cases are often sent to orthopædic physicians for a medico-legal opinion Neurosis is noticeably rare after severe injuries, especially those associated with fractures, for these demand and receive immediate attention. But when a radiograph shows the bones to have escaped injury, treatment of soft tissue lesions is often postponed until chronic disability is already setting in, many patients being ordered rest when in fact what they need is some form of therapeutic movement, and then being sent back to work without adequate rehabilitation first. The sequence of events leading first to doubt then to fear does not get set in motion when a clear diagnosis leads to effective treatment. The reassurance and early active use of the injured part provide an atmosphere and call for behaviour highly discouraging any neurotic tendency.

TYPICAL HISTORY IN TRAUMATIC NEURASTHENIA

This follows a standard pattern. The patient, usually while at work, sustained an injury He may have been incapacitated for the moment, but thought little of it and after a short rest resumed work, continuing for some time, even for the rest of the day. By that evening at the latest, however, the sprained area began to ache badly, and the next morning he found himself very stiff and in pain. If he attempted to work again, the pain became much worse and he was soon brought to a halt. Usually he rested the damaged part and the pain gradually decreased until, after a few weeks, he thought he was quite well enough to use it again. He

then returned to work only to discover that, as soon as a movement similar to that which led to the original injury was attempted, the pain returned, and that it increased in intensity the harder he tried This is a particularly common complaint in lumbar disc lesions. After two or three such failures the patient gave up the effort to return to work.

Lessons to be drawn from the History

The history outlined above illustrates four important points.

1 That minor muscular sprains always, and ligamentous sprains sometimes, cause more pain a day or two after their occurrence than at the time of the injury

2 That a night's rest often aggravates the symptoms, in other words, the absence of movement leads to increased stiffness and pain. This is a clear indication for treatment by movement nevertheless, the indication is often ignored and more rest enjoined upon the patient. The turning point of the patient's disability occurs during these days. If the services of a physiotherapist are called upon at this time, chronic disability can regularly be avoided and the patient made fit to return to work. If on the other hand the patient is treated by rest and then sent back to work, adhesion formation, chronic pain and consequent neurosis based on it may be expected

3 That use and movement are not synonymous Reference has already been made to the paramount importance of mechanical factors in the organization of developing fibrous tissue In the absence of movement proper orientation of this tissue does not take place and a scar forms which is adherent in all directions If, on the other hand the patient returns to work too soon, a series of excessive strains are put upon the delicate new fibroblasts, which rupture repeatedly, with the result that a painful scar forms in the healing breach. The results of suitable therapeutic movements and work can thus be seen to be very different. Moreover, work does not necessarily involve the attainment of a full range of movement in every direction, for the sprained part is usually held stiffly, movement occurring chiefly at adjacent uninjured tissues.

4. That recurrence is common after damage to intra-articular cartilage. A neurasthenic attitude is apt to develop in patients with thoracic or lumbar disc-lesions unless the patient feels that his doctor understands the nature and the likely progress of his case. To be prevented from exertion by accesses of pain the cause of which is not revealed by the "all-seeing eye" (patients' common belief) of radiography gives rise to much speculation. Explanation at the outset that the symptoms result from displacement of a fragment of cartilage—painful but not dangerous—avoids much anxiety.

The Untreated Patient's Further Progress

The next stage in the typical history follows Finding that exertion invariably causes pain, the patient begins to worry about his livelihood, prospects and welfare. He starts pestering his doctor, who insists that a return to work is the best treatment and affords little sympathy when reassurances as to the triviality of the lesion prove unavailing After several unsuccessful attempts, the patient not unreasonably becomes convinced that he will never be fit for heavy work again. His doctor opposes this view, and the patient begins to exaggerate his symptoms so as to make them sound more convincing—with, of course, the opposite result. After some time the patient may conclude that the divergence between his doctor's and his own view of the degree of disability can only be explained by the presence of a serious disease which has remained undiagnosed. To his pain is then added fear—fear due to a misinterpretation of the significance of his symptoms.

In extreme cases the patient may be reduced to a nervous wreck, apt to spend prolonged periods in bed for no adequate reason. He may believe that walking, since it hurts a little, jars the injured part and is thus dangerous He therefore rests apprehensively all day To his previous symptoms are now added the signs of prolonged anxiety: sweating, trembling, palpitation, loss of weight and appetite. At times the neurosis may completely overshadow the slight organic lesion, the patient often complaining of such giddiness, incoordination or weakness of the limbs that he feels too unsafe

to venture upon any activity In some patients this condition develops slowly, over a period of months, in others—particularly those predisposed by emotional instability or dislike of their job—it may appear in a week or two Needless to say these predisposing factors are apt to occur together When these symptoms are present in the absence of any complaint of pain, it is clear that the patient's symptoms are occasioned purely by neurosis and have no longer even a minor organic basis

TREATMENT OF TRAUMATIC NEURASTHENIA

Prophylaxis

This is the essential measure A few days rest in bed, though seldom strictly necessary is quite harmless. As long as the type of treatment required is begun not later than a week after the accident, no harm will have been done apart from the fact that, had the patient been seen on the day of the injury, treatment by local anæsthesia would have been at its most effective. Rest in bed, when prescribed, should be regarded merely as a brief preliminary to physiotherapy Neurosis, depending as it so often does on chronic disability for its inception, gets no chance to appear when treatment is begun early The repeated reassurances of the physiotherapist, the fact that active use of the injured part is found possible, and the diminution in pain and stiffness which result from this treatment, encourage the patient to focus his attention on getting well.

It might seem that least time would be wasted if physiotherapy were administered at a clinic situated at the factory Except in the case of fractures this practice has not in my experience proved a great success. Better and quicker results follow attendance at a centre staffed by an orthopædic physician even if the clinic is some distance away

Treatment of Established Neurasthenia

This depends on the basis on which the neurosis rests If there exists some more or less painful organic lesion on which the patient's fear is founded he must be deprived

of it. If this is not possible, its harmless nature must be emphasized, in particular that it is not the prelude to some crippling disease spreading from joint to joint

The site of chronic soft tissue lesions must be detected in spite of the difficulties that the patient's psychogenic overlay presents. Treatment follows the lines laid down in previous chapters, but, in addition, his anxiety must be allayed by constant explanations, reassurance and exhortation Thoroughness and perseverance bring their reward.

When a compensation case is pending and the disability is long-standing it is usually wise to postpone treatment until the suit is decided In the present state of the law, harm is done to the patient's case if he improves; hence it is unreasonable to ask a man to work hard to rid himself of a disability in which he has a financial stake His co-operation is obtained as soon as the matter is settled

THE RADIOGRAPH IN MEDICO-LEGAL CASES

In patients complaining of persistent pain as a consequence of some accident a decision on the relevance of radiographic abnormalities is beset by many pitfalls. It is my view that in nearly every case the clinical findings take precedence over changes detectable on the radiograph Rarely the photograph may show an over-riding lesion that clinical examination did not detect; then only is it diagnostic taken alone

Much unfairness results from excessive reliance upon radiography. For example, slight symptomless wedging following injury to a vertebral body may be regarded as clear proof of allegedly severe pain, and some patients, after being made aware of the radiographic abnormality, trade on this knowledge. By contrast, patients in real pain, but with a normal x-ray picture, may receive scant consideration.

Comparison of the clinical and radiological evidence leads to four main types of conclusion.

1. *The Radiograph confirms the Clinical Findings or is itself Diagnostic.* In such cases there is happily no conflict of evidence and the x-ray photograph lends precision to the clinical diagnosis. Alternatively, it may reveal a lesion

almost impossible to detect clinically in its early stage, *e.g* tuberculous caries of the thoracic spine.

There remains to assess the degree of disability set up by the lesion, a purely clinical task, and to arrive at a considered prognosis.

2 *The Radiograph confirms the Past Occurrence of an Injury but is not clearly Relevant to the Patient's Symptoms* In the first place, difficulty may arise in determining whether the injury in question or some previous accident resulted in the abnormality detected on the radiograph Pictures taken soon after an accident reveal the difference between recent and long-standing bony changes, but after a time no limiting date can be given In the second place, it must not be forgotten that bony abnormalities, both congenital and acquired, may be revealed by chance on a radiograph taken for some other reason The history may disclose that a fracture occurred several decades ago set up only transient stiffness then and no symptoms since Hence the presence of such abnormalities does not afford unequivocal evidence of the presence of pain If the symptoms and results of clinical examination are both consistent with a lesion at this site, the relevance of the radiographic appearances to the pain is clear If, by contrast, the symptoms are felt at a site inconsistent with such a lesion, it cannot possess a direct bearing For example, once bony union is complete wedging of a vertebral body cannot of itself set up pain, let alone unilateral pain. Equally, fracture of a vertebral transverse process does not give rise to bilateral pain. The most that can be said of such evidence of damage to bone is that the accident was evidently severe. In such cases, if a soft tissue lesion is found to explain the symptoms, the radiographic appearances largely corroborate the patient's contention that it is the result of injury

The radiograph may show some condition like osteoarthritis at an age when this is a normal finding The existence of marked osteophyte formation confined to one side only of a large joint such as the knee strongly suggests a traumatic ætiology

3 *The Radiograph is Uninformative* Normal radiographic appearances cannot be held to preclude the existence of organic disorder any more than every visible abnormality

indicates the presence of pain. Most painful soft tissue lesions give rise to no radiographic signs Only clinical examination can reveal lesions such as tennis-elbow, supraspinatus tendinitis, early infective arthritis, displacement of a fragment of spinal intervertebral disc, early gout, ligamentous sprains, or rupture of the meniscus at the knee-joint, to mention only a few common conditions.

4. *The Radiograph is Misleading.* Shadows may be seen on the radiograph that suggest a diagnosis which clinical examination shows to be false. Small opacities in a ligament, tendon or bursa provide no evidence that any pain experienced in that region springs from the structure to which attention has been drawn Small areas of calcification in, for example, the supraspinatus tendon or the tibial collateral ligament of the knee are usually accompanied by perfect function. Quite large areas of calcification of the subdeltoid bursa may be wholly symptomless. Again, an appreciable degree of osteophyte formation at joints such as the intervertebral, knee or tarsal is consistent with normal function. Osteophyte formation at the sacro-iliac joint shows commencing ossification of the ligaments and proves the joint to be stable and painless. X-ray evidence suggesting osteoarthritis in the joint of a sacralized fifth lumbar transverse process has never in my experience proved relevant to backache Such instances could be multiplied and show once more the paramount importance of clinical examination.

CHAPTER XXV

PHYSICIAN AND PHYSIOTHERAPIST

ON the orthopædic physician and the physiotherapists he directs depends a good deal of the industrial effectiveness of the nation. Between them they treat vast numbers of patients the period of whose disablement depends largely on the accuracy with which physician and physiotherapist do their work. Consider, for example, the man who instead of spending a month in bed recovering from lumbago, after a manipulation goes back to work the following day, or the sprained medial ligament at the knee that gets well in two weeks instead of two months because of adequate massage. Consider too the man off heavy work for many months because of a tennis-elbow or permanently incapacitated on account of supraspinatus tendinitis—both conditions regularly curable by physical methods

The relative importance to the economic life of the nation of proper treatment for the disorders dealt with in this book increases daily As more and more of the bacterial diseases come under control because of the elaboration of effective remedies, so much does invalidism from orthopædic causes provide an ever increasing proportion of the total The advent of the sulphonamides, penicillin and chloramphenicol, to mention only a few, has reduced enormously the period of disablement from diseases hitherto grave and often lethal The fact throws into ever increasing prominence the economic importance today and more still tomorrow of orthopædic medicine.

ECONOMIC ASPECT

What is called ' rheumatism" is stated to be responsible for 10 per cent of the work of general medical practitioners, according to the Scottish Medical Committee s report (1945) and 15 per cent according to the Minister of Health in 1946 The term rheumatism was used to include a large number of cases of non rheumatic disorders like lumbago (internal

1. *Diagnostic Responsibilities*

(*a*) *Positive Localization.* The most obvious necessity is the arrival at a diagnosis correct in detail and the issuing of clear instructions based thereon to the staff. This subject requires emphasis chiefly because the idea of treatment is apt to be paramount in physiotherapy departments to the detriment of a proper interest in diagnosis first. If patients are not thoroughly examined until the source of their trouble is clearly defined, the labels applied in a physiotherapy department are apt to become dull routine words devoid of localizing significance. When, on the other hand, the matter of diagnosis is taken seriously, the problems encountered are no less interesting than, though of a different kind from, those of other branches of medicine Readers will, I hope, forgive me if I repeat that such bald terms as sprained knee, painful shoulder, lumbar strain, flat feet, peri-arthritis, fibrositis, and rheumatism are paraphrases of patients' complaints and in no sense a diagnosis Mere translation of patients' words into Latin or Greek equivalents cannot provide a basis for the prescription of accurate treatment.

It is by watching how examination unravels a mass of unclear symptoms that students of medicine, no less than students of physiotherapy, get to know how such a search is conducted. Moreover, only if the exact site of lesions is repeatedly pointed out to them can they come to realize what are the common conditions responsible for somatic pain and how to recognize them.

There is another aspect to this matter. It is clear that students of physiotherapy cannot be taught accurate treatment except on the basis of an equally accurate diagnosis. We must therefore look to the physicians attached to the Training Schools for the precision that alone makes possible adequate teaching on the important remedial massage and manipulative techniques that have now been included in the syllabus.

(*b*) *Negative Localization.* Another responsibility, no less to himself than to his staff, is the detection of gross exaggeration and of symptoms devoid of organic basis. The short course of stimulating measures that the physiotherapist can administer with confidence in cases of psychogenic pain is

very different in type and result from vague treatment hesitantly given to a patient alleging much disability of uncertain origin Moreover, no true estimate of the effects of treatment can be arrived at unless psychogenic disorders are sorted out first and discarded from the series, for dramatic cure following any measure may lead the doctor off on an entirely false trail unless the absence of organic change had been detected

2 *Teaching Medical Students*

In spite of the fact that the conditions treated in a physiotherapy department comprise some of the commonest disorders with which any medical practitioner normally has to deal every day, his undergraduate teaching on these subjects is apt to be very sketchy Patients with this type of lesion seldom require admission to teaching hospital beds Moreover, questions on this subject are not normally set in the examinations. It happens, therefore, that a medical man is often called upon to instruct a physiotherapist, though he may have no great experience in the pitfalls of diagnosis with a view to physiotherapy nor a very clear grasp of the principles on which treatment should be based. The only person who can remedy this state of affairs is the orthopædic physician who since attendance at his clinics is not compulsory, can only attempt to make his work interesting to students by explaining how the purpose of diagnosis with a view to physiotherapy is often anatomical localization of the tissue at fault, and letting them follow him in his deductions from the history the responses to diagnostic movements and, where suitable, to local anæsthesia

Much of the work is an exercise in referred pain the action of muscles and the range of movement of joints is repeatedly examined Moreover, the outline of the dermatomes and the segmental origin—and by corollary the nerve-supply—of muscle has to be kept in mind Attendance at diagnostic clinics in a physiotherapy department provides excellent lessons in applied anatomy and is therefore, particularly well-suited to students recently examined in anatomy They should also watch manipulative reduction carried out at the knee, elbow cervical, thoracic and lumbar joints, and see for themselves how the physical signs regress from

eventually spend as many hours with the patient as the physician has spent minutes, who is in the best position to help him in difficult cases. Her opinion may fruitfully be sought both in cases in which the site of the lesion is uncertain and when the question of a possible psychogenic disability arises. The physiotherapist, by her repeated examination of the painful area and its movements, may discover organic signs, alternatively inconsistencies, that had escaped the doctor's notice. As she is naturally hesitant to put her views forward unless asked, she should be invited to give her views when patients whose response to treatment is disappointing are seen again. She should be asked if she has any reason to offer why a patient is not progressing, and may have an illuminating opinion. Due weight should be given to her suggestions and, if the physician's and physiotherapist's views differ, the patient should be examined all over again in her presence and local anæsthesia used whenever possible to decide the issue. This attitude makes students think, thereby increasing their interest in their work and their value to both patient and doctor. I, for one, have learnt much from the suggestions, criticisms and questions put to me by my students no less than by my staff. Some of the methods described in Vol. II originate from such co-operation, which has been of the utmost value I am happy here to acknowledge my debt.

6. *Protection of the Department*

Only the orthopædic physician can protect his department from misuse. Whereas the fact that patients with every sort of obscure pain are referred to the department should be welcomed as providing him with a series of interesting diagnostic problems, this does not imply that the department is a suitable dumping ground for the incurable. Nothing is more disheartening to the staff, or greater waste of time for patients, than endless attendances for treatment that secures at the most some hours' slight alleviation. Patients capable of being afforded full relief should be treated until well; patients who can be improved should be kept on treatment until the maximum benefit has been obtained; for patients intractable by physiotherapy alternative methods should

be considered, e.g orthopædic operations, instruments, anal genes, spa treatment, a home help, and so forth

It is amazing how patients will come regularly for treatment perhaps over a period of years, though no lasting benefit is obtained. Hope and habit combine to prevent their realization of time wasted and the uselessness of the measures employed Nevertheless, the time spent and the personal attention given by the staff of a physiotherapy department render it a most unsuitable and expensive resort for ephemeral palliation.

7 *Revision of Text-books*

Mr N G. Lake, reviewing the seventh edition of a well known text book on physiotherapy, states

" We wonder after reading this book, whether physiotherapeutic procedures are not being used in unsuitable cases For instance, we see an account of the application of these methods to the treatment of blood diseases—e.g pernicious anæmia—and hæmorrhoids and the question comes to mind whether the interests of a large profession have not caused disease to become the handmaiden of massage rather than made massage serve the cure of disease. It seems that this branch of treatment, of such great benefit in appropriate cases, is showing signs of becoming a complete system of treatment, like osteopathy, naturopathy, and others. The wide scope of this book is likely to mislead the student into believing that there is scarcely any disease which should not be treated by the methods advocated It would be unfortunate if this idea spread, for physiotherapy should be used only in certain cases and remain subservient to other forms of treatment.

A leading article in the *British Medical Journal* makes a similar point

' Under the National Health Service physiotherapists will presumably form part of the therapeutic team led by the doctor But team work will not be easy if the members no longer think along the same lines Pathology connotes one thing to the doctor to the physiotherapist often quite another Physiotherapists are taught their medicine by their own teachers. It is understandable that to the physiotherapist the treatment of rickets and lupus vulgaris is general

and local ultra-violet irradiation, despite the potent remedies available in vitamin D and calciferol. But it is less understandable that to the physiotherapist the treatment of gout is lithium ionization, when the use of lithium in any form is rejected by no less an authority than Professor Henry Cohen. 'Hepatic massage' is advocated for right heart failure in a book written for physiotherapists by a teacher of physiotherapy and published in 1948. Similarly 'abdominal massage' is advocated for 'gastritis.' There are other instances which might be taken to indicate that physiotherapy is establishing a pathological and therapeutic system of its own. . . ."

Dr. W. Tegner, reviewing a guide to physiotherapy first published in 1953 states: "Finally, we are presented with a list of conditions for which certain forms of physiotherapy are advocated. This covers more than 200 conditions, ranging from purulent keratitis to hæmorrhoids. . . . Such statements will undo much of the good impression given by the early chapters. . . ."

These three extracts are quoted to make it clear that I am not alone in considering that the time has come for drastic revision of many standard works, the omission of many claims unsupported by evidence and the inclusion of much vital new matter disclosed by corroborated research. In particular, Sir Thomas Lewis's work on referred pain (1936) and the practical results that flow from these fundamental discoveries ought to be given prominence.

BEDS

Hospital beds are no problem to an orthopædic physician who works as one of the orthopædic team. Until this happy collaboration becomes established, he remains physician to a department catering wholly for out-patients. But he is placed at a real disadvantage unless he has immediate access to at least one male and one female bed.

Quite a number of conditions with which he normally deals call for in-patient treatment But they fall within the province of neither the neurologist nor the orthopædic surgeon and, since they have very little teaching value, are naturally not welcomed in beds belonging to either colleague. For

example, an irreducible acute stiff neck may require immediate traction in recumbency or a patient with severe lumbago may need prolonged general anæsthesia at once. By the time such a patient is admitted to a colleague's bed, the optimum moment for treatment is apt to have passed Hence, for the proper performance of his work the orthopædic physician needs at least one bed

DIPLOMA IN PHYSICAL MEDICINE

Ten years ago, when the Diploma was first instituted, I protested in vain against the omission of diagnosis from the examination. I am happy to say that the word " diagnosis now appears in the syllabus At that time, it is true, no text book had appeared dealing systematically with the diagnosis of soft tissue lesions in the moving parts of the body, but the publication of the first edition of this book ten years ago made no apparent difference. The examination for the Diploma has many good points, but so much vital matter is patently omitted that the result is one-sided

Part I is concerned with applied physics and physiology, it attracts those medical men with a bent towards applied mathematics The candidate is required to understand the construction and uses of electro-diagnostic and electro-therapeutic apparatus, but need know nothing of the technique of massage or manipulation Part II deals with general medicine and rehabilitation

The possession of the Diploma ensures that the holder has an excellent grasp of the properties of rays and of the electrical phenomena useful in diagnosis and treatment he is well fitted for research on myo-neural physiology and pathology It does not imply, alas, that he possesses any special knowledge of the methods (other than electrical) required in the clinical examination of patients suffering from the types of disorder most often seen in the department, or with the methods (other than electrical and gymnastic) for their relief

This unfortunate bias towards physics and its applications means that almost the whole of orthopædic medicine falls outside the scope of the Diploma Moreover budding

clinicians are apt to boggle at a great deal of physics Hence doctors inclined away from clinical work are attracted to the Diploma, but those with clinical aptitude are put off. Since the possession of this Diploma is often required of applicants for a post in a physical medicine department, the result is that those doctors most attuned to the exactitudes of physics are to be found clinically examining patients referred to the department. This is an increasingly widespread tendency, which the whole matter contained in this book seeks to reverse It is to be hoped that, with the development of orthopædic medicine, it will become possible to put the examination for the Diploma on a broader base, so that its possession guarantees that the holder has a working knowledge of all the principal methods for arriving at a diagnosis—clinical as well as electrical—in lesions affecting the moving parts of the body, together with some acquaintance with manual as well as electrical treatment.

Alternatively, since their work is so different, the two sections of the department could be split apart overtly as well as factually. This would mean the formation of a department of electro-diagnosis, working in close association with the departments of general medicine and neurology. The rehabilitational aspect of physical medicine could then be conducted by a separate department under the ægis of the orthopædic physician, as one of the orthopædic team.

DOCTOR AND PHYSIOTHERAPIST

" If the general practitioner and the medical profession insist that the auxiliary medical services are to be operated at their motivation, and within their own field, there is an obligation on the general medical profession to acquire the knowledge that is needed to do it intelligently " (the Minister of Health, January 5th, 1946).

This is an excellent principle, difficult to put into practice, since most physiotherapists receive their instructions from medical men who have not made a special study of orthopædic medicine. Thus, the dilemma that may trouble the relationship between the professions can be simply stated in a few words. Many doctors, lacking full insight into the tech-

nical problems of orthopædic medicine, formulate their instructions without enough regard for the special requirements of physiotherapists Physiotherapists, on the other hand, possess only a very limited diagnostic ability and thus tend in the absence of suitable instruction, to apply treatment wanting in definiteness of purpose Moreover, accurate techniques of massage and manipulation were first given adequate prominence in physiotherapy students' syllabus in 1952 This meant that, even if every training school had been able to find competent teachers at once, it would have been two years before the first batch of students grounded in such methods qualified But, as it turned out, the addition was largely ignored Hence, there exist deficiencies both on the medical and the physiotherapeutic side

Diagnosis of lesions affecting the moving parts of the body should be taught to medical students from the orthopædic physician's as well as the orthopædic surgeon's point of view At St. Thomas's Hospital I have found that a lecture-demonstration once a week for six months covers the ground Attendance is voluntary Since questions relating to orthopædic medicine are not asked in students' qualifying examinations, a certain lack of enthusiasm is inevitable. This is most understandable However the rarity of some students' attendance is be to deplored largely for their own sakes, for about a fifth of the patients seen by a general practitioner during his daily work consists in sufferers from the very soft tissue lesions affecting the moving parts of the body with which orthopædic medicine deals and for which physical methods or injections at a precise spot provide the remedy I go further than this, though quite unofficially Not only do I teach our junior physiotherapy students the accurate manual techniques that are required in treatment, but I also teach our senior physiotherapy students what are the common conditions affecting each part of the body in turn, and how they are identified This grounding enables a physiotherapist, when a doctor honours her by letting her choose her own technique, to determine for herself the site of the lesion and thus make a logical decision based on a clear understanding of the nature of the case. Such teaching detracts nothing from the medical practitioner's responsibility in instructing a physiotherapist it merely enables him to use general terms when

of purpose has, therefore, to be exercised to prevent the patient's indication from exerting too great an influence during the search for the source of a pain. In fact, such firmness can be imparted only by instruction in the basic principles of the manner of localization of lesions from which diffuse pains originate, and by regular practice in these methods during a student's final year. Such teaching does, as a matter of observed fact, lead to real understanding of how to set about finding the source of a pain

Our senior students receive from me a lecture once a week for six months on the nature and identification of the lesions commonly sent to a physiotherapy department for diagnosis and treatment For two or three months they also attend the weekly diagnostic clinic held for their benefit. A great deal of time is not therefore taken out of the standard curriculum and, though this knowledge has no particular examination value, it is, so I have been assured by our graduates, vital to the quality of their postgraduate work. It gives them a logical approach to any disorder and enables them to use accurate and quickly effective techniques to the advantage of their patient, themselves and the status of their profession.

FINANCIAL QUESTIONS

Doctors in general practice often ask how they can be expected to provide for the treatment of patients with modest means suffering from lesions of the moving parts of the body. In theory, of course, the physiotherapy department of the nearest hospital possesses the necessary facilities; in practice, until the training of physiotherapy students becomes much more advanced, accurate massage and manipulation are seldom obtainable there The only solution is the employment of a suitably trained physiotherapist by the practitioners themselves The following note was written by one of our graduates at my request:

A group of six medical men doing mainly National Health Service work in a country town and the surrounding rural area employs a full-time physiotherapist. She practises privately, entirely outside the N.H.S. Besides serving

her employers, she accepts patients from the other doctors in the neighbourhood, who number eight.

Her department was started over four years ago A large room was fitted out with central heating and divided by running curtains into four cubicles The equipment includes a car with mobile apparatus for domiciliary visits, a U S W machine, a traction table, a head suspension apparatus, three heat lamps, faradic and galvanic batteries, Guthrie-Smith apparatus, wall bars, wax bath and ultra violet lamps.

After allowance for all expenses, including the remunera tion of the physiotherapist, the department has shown a profit each year and has paid for all the equipment listed above except the car

Special emphasis has been laid both by the doctors and by the physiotherapist on correct diagnosis and the accurate localization of lesions. This has reduced the number of treatments necessary for full recovery and thereby increased the usefulness of the department, since patients of limited means find they obtain relief from two or three treatments rather than from a more extended course of less precise measures gratuitously elsewhere The swift recovery thus obtained, especially in ligamentous sprains, strained tendons and disc-lesions, has encouraged local employers of labour to demand private attention for workers who otherwise would have been unable to obtain treatment by manipulation or accurate massage. The members of the medical partnership are satisfied that the addition of a physiotherapist to the group has not only increased the therapeutic effectiveness of the whole but has also proved to be economically sound

FINDING A PHYSIOTHERAPIST

Doctors who wish to know the names of members of the Chartered Society of Physiotherapists practising in their neighbourhood should write to the Society at Tavistock House (South) Tavistock Square, London, W C.1 There has been no full directory of members issued since 1947

Those who wish to know the name of the nearest physiotherapist trained by myself in the methods set out in Volume II are invited to write to me at St Thomas s Hospital.

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